United States Department of the Interior

NATIONAL PARK SERVICE

Chickasaw National Recreation Area

1008 West 2nd Street

Sulphur, Oklahoma 73086

IN REPLY REFER TO:
W42 (CHIC)
(X)L3425

March 10, 2003

Dear Interested Party,

The National Park Service respectfully submits this copy of the Chickasaw National Recreation Area Personal Watercraft Draft Environmental Assessment (EA), which analyzes the impacts of personal watercraft use at the park unit in accordance with the National Environmental Policy Act and Director's Order 12. The National Park Service prepared this EA in conjunction with a draft special regulation authorizing personal watercraft use at Chickasaw National Recreation Area.

Completion and implementation of the regulation requires the National Park Service to comply with the National Environmental Policy Act, which calls for the evaluation of alternatives and their impacts. This examination of alternatives is the content of the Environmental Assessment (EA). The 30 calendar-day public review period begins on the date of this letter. If you wish to comment on the document, you may submit your comments by any one of several methods: you may mail or hand-deliver written comments to Superintendent, Chickasaw National Recreation Area, 1008 West 2nd Street, Sulphur, OK 73086; you may electronic mail to chic_pwc_ea@nps.gov or you may fax to (580) 622-2296.

At a later date, you will be able to comment on the draft special regulation during the designated 60-calendar-day public review and comment period, which will begin on the date that the regulation is published in the Federal Register. If you wish to comment on this rule, you may submit your comments by any one of several methods: you may mail or hand-deliver written comments to Superintendent, Chickasaw National Recreation Area, 1008 West 2nd Street, Sulphur, OK 73086; you may electronic mail to chic_pwc_ea@nps.gov or you may fax to (580) 622-2296.

Our practice is to make comments on the special regulation and the EA, including names and addresses of respondents, available for public review during regular business hours. Individual respondents may request that we withhold their home address from the rulemaking record, which we will honor to the extent allowable by law. If you wish us to withhold your name and/or address, then you must state this prominently at the beginning of your comment. However, we will not consider anonymous comments. We will make all submissions from organizations, businesses, or individuals identifying themselves as representatives or officials of organizations or businesses available for public inspection in their entirety.

We thank you in advance for your attention, and we appreciate your concern for the future of Chickasaw National Recreation Area.

Sincerely,
/s/
John F. (Rick) Shireman
Superintendent

Enclosure

National Park Service
U.S. Department of the Interior

Chickasaw National Recreation Area
Oklahoma

CHICKASAW
NATIONAL RECREATION AREA

Personal Watercraft Use
Environmental Assessment

Printed on recycled paper

National Park Service
U.S. Department of the Interior

Chickasaw National Recreation Area
Oklahoma

CHICKASAW
NATIONAL RECREATION AREA

Personal Watercraft Use
Environmental Assessment

February 2003

SUMMARY

Chickasaw National Recreation Area was established as a unit of the national park system, on March 17, 1976. A primary recreation feature of Chickasaw is Lake of the Arbuckles, created in 1967 as a public water supply reservoir. The goal of the national recreation area is to provide each visitor with an educational, enjoyable, safe, and memorable experience. Chickasaw is located on U.S. Highway 177, just south of the town of Sulphur, Oklahoma, and approximately 90 miles south of Oklahoma City.

The purpose of and the need for taking action is to evaluate a range of alternatives and strategies for managing personal watercraft (PWC) use at Chickasaw to ensure the protection of park resources and values while offering recreational opportunities as provided for in the national recreation area's enabling legislation, purpose, mission, and goals. Upon completion of this process in accordance with the National Environmental Policy Act (NEPA), the National Park Service (NPS) may either take action to adopt special regulations to manage PWC use, or it may discontinue PWC use at this park unit.

BACKGROUND

More than one million PWC are estimated to be in operation today in the United States. Sometimes referred to as "Jet Skis" or "Wet Bikes," these vessels use an inboard, internal combustion engine powering a water jet pump as its primary source of propulsion. They are used for enjoyment, particularly for touring and maneuvers such as wave jumping, and they are capable of speeds in the 60-mph range. While PWC use remains a relatively new recreational activity, it has occurred in 32 of the 87 national park system units that allow motorized boating.

After studies in Everglades National Park showed that PWC use resulted in damage to vegetation, adversely impacted shorebirds, and disturbed the life cycles of other wildlife, the National Park Service prohibited PWC use by a special regulation at the park in 1994. In recognition of its duties under its Organic Act and NPS *Management Policies,* as well as increased awareness and public controversy about PWC use, the National Park Service subsequently reevaluated its methods of PWC regulation. Historically, the National Park Service had grouped personal watercraft with all vessels; thus, PWC use was allowed when the superintendent's compendium allowed the use of other vessels. Later, the National Park Service closed seven units to PWC use through the implementation of horsepower restrictions, general management plan revisions, and park-specific regulations such as those promulgated by Everglades National Park.

In May 1998, the Bluewater Network filed a petition urging the National Park Service to initiate a rulemaking process to prohibit PWC use throughout the national park system. In response to the petition, the National Park Service issued an interim management policy requiring superintendents of parks where PWC use can occur but had not yet occurred to close the unit to such use until the rule was finalized. The National Park Service envisioned the servicewide regulation as an opportunity to evaluate impacts from PWC use before authorizing the use. On March 21, 2000, the National Park Service issued a regulation prohibiting PWC use in most units and required 21 units to determine the appropriateness of continued PWC use.

In response to the PWC final regulation, Bluewater Network sued the National Park Service, challenging the agency's decision to allow continued PWC use in 21 units while prohibiting PWC use in other units. In response to the suit, the National Park Service and the environmental group negotiated a settlement. Each park desiring to continue long-term PWC use was to promulgate a park-specific special regulation in 2002. In addition, the settlement stipulates that the National Park Service must base its decision to issue

a park-specific special regulation to continue PWC use through an environmental analysis conducted in accordance with the National Environmental Policy Act (NEPA). The NEPA analysis at a minimum, according to the settlement, must evaluate PWC impacts on water quality, air quality, soundscapes, wildlife, wildlife habitat, shoreline vegetation, visitor conflicts, and visitor safety.

As the settlement deadline approached and the park units were preparing to prohibit PWC use, the National Park Service, Congress, and PWC user groups sought legal methods to keep the parks open to this activity. However, no method was successful. On November 7, 2002, this park unit closed to PWC use. If as a result of this environmental assessment an alternative is selected that would allow PWC use to continue, then a special regulation to authorize that use will be drafted.

ALTERNATIVES CONSIDERED

This environmental assessment evaluates four alternatives concerning PWC use at Chickasaw.

- *Alternative A* — Continue PWC use under a special NPS regulation.
- *Alternative B* — Continue PWC use under a special regulation with additional management prescriptions (preferred alternative).
- *Alternative C* — Continue PWC use under a special regulation but limit area of use and implement other restrictions.
- *No-Action Alternative* — Eliminate PWC use entirely.

Based on the environmental analysis prepared for PWC use at Chickasaw, alternative C is considered the environmentally preferred alternative because it would best fulfill park responsibilities as trustee of this sensitive habitat; ensure safe, healthful, productive, and aesthetically and culturally pleasing surroundings; and attain a wider range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable and unintended consequences.

ENVIRONMENTAL CONSEQUENCES

Impacts of the four PWC management alternatives were assessed in accordance with *Director's Order #12: Conservation Planning, Environmental Impact Analysis and Decision-making* (DO #12). The *DO #12 Handbook* requires that impacts to park resources be analyzed in terms of their context, duration, and intensity. It is crucial for the public and decision-makers to understand the implications of those impacts in the short and long term, cumulatively, and within context, based on an understanding and interpretation by resource professionals and specialists.

To determine impacts, methodologies were identified to measure the change in park resources that would occur with the implementation of the PWC management alternatives. Thresholds were established for each impact topic to help understand the severity and magnitude of changes in resource conditions, both adverse and beneficial.

Each PWC management alternative was compared to a baseline to determine the context, duration, and intensity of resource impacts. The baseline, for purposes of impact analysis, is the continuation of PWC use and current management projected over the next 10 years (alternative A).

Table A summarizes the results of the impact analysis for the impact topics that were assessed. The analysis considered a 10-year period (2002–2012).

Table A: Summary of the Impact Analysis

Impact Topic	Alternative A: Continue PWC Use under a Special NPS Regulation	Alternative B: Continue PWC Use under a Special NPS Regulation with Management Restrictions	Alternative C: Continue PWC Use but Limit Area of Use and Implement Other Restrictions	No-Action Alternative — No PWC Use
Water Quality	PWC use impacts: Negligible adverse impacts in 2002 and 2012 except minor adverse impacts from benzene (human health benchmark) in Lake of the Arbuckles (area 1) in 2002 and 2012, and moderate adverse impacts in 2002 in no-wake zones (area 2), decreasing to minor by 2012. Cumulative impacts: Negligible adverse impacts in 2002 and 2012 except potentially major adverse impacts from benzene (human health) in 2002 in areas 1 and 2, decreasing to moderate in both areas by 2012. Possibly greater benzene impacts if a strong thermocline developed, thus reducing the mixing and dilution volume. Water quality monitoring needed to confirm impacts after a high-use day.	PWC use impacts: Same as alternative A. Cumulative impacts: Same as alternative A except impacts also reduced by prohibiting refueling operations on the water.	PWC use impacts: Similar to alternative A except moderate impacts from benzene (human health) in 2002 in Lake of the Arbuckles (area 1) and no-wake zones (area 2), decreasing to negligible by 2012; no impacts in area closed to PWC use (area 3). Cumulative impacts: Similar to alternative A with potentially major adverse impacts from benzene (human health) in area 1 in 2002, decreasing to moderate in 2012; moderate impacts in area 2, decreasing to minor by 2012; and moderate impacts in area 3 in both 2002 and 2012. Impacts also reduced by prohibiting refueling operations on the water.	PWC use impacts: Beneficial impacts from discontinuing PWC use. Cumulative impacts: Similar to alternative A, with potentially major impacts from benzene (human health) in Lake of the Arbuckles (area 1) in 2002, decreasing to moderate by 2012; moderate adverse impacts in the no-wake zones in 2002, decreasing to minor by 2012.
Air Quality				
• Impacts to Human Health from Airborne Pollutants Related to PWC Use	PWC use impacts: Moderate adverse impact from CO, minor adverse impact from VOC, and negligible adverse impacts from PM_{10} and NO_x in 2002. In 2012 moderate adverse impact from CO, and negligible adverse impacts from VOC, PM_{10}, and NO_x. Cumulative impacts: Negligible adverse impacts from PM_{10} and NO_x in 2002 and 2012; moderate adverse impacts from CO in 2002 and 2012; and moderate adverse impact from VOC emissions in 2002, decreasing to minor in 2012. Existing air quality maintained, with future reductions in PM_{10}, HC, and VOC emissions due to improved emission controls.	PWC use impacts: Similar to alternative A except emissions slightly reduced because of extending the no-wake zone in the Buckhorn developed area. Cumulative impacts: Similar to alternative A.	PWC use impacts: Similar to alternative A except emissions reduced compared to alternative A because of expanding no-wake zones and closing areas to PWC use. In 2012 minor impacts from CO due to an overall reduction in carbureted two-stroke engines. Cumulative impacts: Similar to alternative A except minor adverse impacts from VOC in 2002, decreasing to negligible by 2012. Existing air quality maintained with future reductions in PM_{10}, HC, and VOC emissions due to anticipated improved emission controls and banning two-stroke carbureted PWC engines in 2005.	PWC use impacts: Beneficial impacts from banning PWC use because of decreased emissions. Cumulative impacts: Reduced emissions from all other motorized watercraft compared to alternative A, with no contribution from PWC use. Moderate adverse impacts from CO and negligible adverse impacts from PM_{10}, VOC, and NO_x in 2002 and 2012.
• Impacts to Air Quality Values from Pollutants Related to PWC Use	PWC use impacts: Negligible adverse impacts on visibility in both 2002 and 2012. Minor adverse impact from ozone exposure in 2002 and 2012. Minor overall impact to air quality related values Cumulative impacts: Negligible visibility impacts, minor adverse impacts from ozone exposure in 2002 and 2012. Elevated ozone levels primarily a result of ozone and precursor pollutants being	PWC use impacts: Similar to alternative A. Cumulative impacts: Similar to alternative A.	PWC use impacts: Similar to alternative A Cumulative impacts: Similar to alternative A.	PWC use impacts: Beneficial impacts on air quality related values. Cumulative impacts: Similar to alternative A.

Impact Topic	Alternative A: Continue PWC Use under a Special NPS Regulation	Alternative B: Continue PWC Use under a Special NPS Regulation with Management Restrictions	Alternative C: Continue PWC Use but Limit Area of Use and Implement Other Restrictions	No-Action Alternative — No PWC Use
	transported from northern Texas, not a result of local conditions, Overall impacts anticipated to be minor in 2002 and 2012 when considered in the context of the regional setting.			
Soundscapes	PWC use impacts: Minor to moderate, temporary, adverse impacts over the short and long term at most locations on Lake of the Arbuckles and the immediate surrounding area. Over the long term reduced PWC noise levels due to newer engine technologies. Cumulative impacts: Minor to moderate adverse impacts, with motorized sounds heard occasionally throughout the day and possibly predominating on busy days during the high-use season.	PWC use impacts: Similar to alternative A except beneficial impact from expanding the no-wake zone around the Buckhorn developed area. Cumulative impacts: Similar to alternative A.	PWC use impacts: Minor, temporary, adverse impacts over the short and long term at many locations on Lake of the Arbuckles and the immediate surrounding area, with potentially moderate, temporary impacts at some high-use areas. Beneficial impact from PWC use restrictions due to reduced noise levels and periods of potential impact. Cumulative impacts: Similar to alternative A except impacts more often minor than moderate.	PWC use impacts: Beneficial impact from banning PWC use, especially on high-use days when personal watercraft comprise 20%–30% of total motorized use. Cumulative impacts: Similar to alternative a except no contribution from personal watercraft.
Wildlife and Wildlife Habitat	PWC use impacts: Negligible to minor, temporary impacts. Cumulative impacts: Negligible to minor adverse impacts.	PWC use impacts: Similar to alternative A. Cumulative impacts: Similar to alternative A.	PWC use impacts: Similar to alternative A except some beneficial effect as a result of restricting PWC use at certain times and in certain locations, as well as requiring personal watercraft to meet the EPA emission standards by 2005. Direct impacts eliminated in all areas closed to PWC use. Cumulative impacts: Similar to alternative A.	PWC use impacts: Beneficial impact due to eliminating PWC use, with some animals potentially reinhabiting or using areas closed to PWC use. Cumulative impacts: Similar to alternative A except no PWC contribution to overall impacts.
Threatened, Endangered, or Special Concern Species	PWC use impacts: May affect, but not likely to adversely affect, any listed wildlife or plant species. Long term water quality impacts on the amphipod are not known. Cumulative impacts: Not likely to adversely affect listed wildlife species because they are transient winter residents, no jeopardy to individual plant species populations within the park.	PWC use impacts: Similar to alternative A. Cumulative impacts: Similar to alternative A.	PWC use impacts: Similar to alternative A except no impacts in areas where PWC use prohibited. Cumulative impacts: Similar to alternative A.	PWC use impacts: No effect on the special status species because of a ban on PWC use. Cumulative impacts: Similar to alternative A except no contribution to overall impacts from PWC use.
Shorelines and Shoreline Vegetation	PWC use impacts: Negligible to minor, localized adverse impacts over the short and long term, with no perceptible changes in plant community size, integrity, or continuity. Cumulative impacts: Negligible to minor, short and long term, adverse impacts.	PWC use impacts: Similar to alternative A except beneficial feedback from monitoring in certain areas. Cumulative impacts: Same as alternative A.	PWC use impacts: Beneficial impacts from restricting PWC use over the short and long term, with no perceptible changes in plant community size, integrity, or continuity. Cumulative impacts: Similar to alternative A with a negligible reduction of overall impacts by restricting PWC use.	PWC use impacts: Beneficial impacts over the short and long term from banning PWC use. Cumulative impacts: Same as alternative A, with a negligible reduction of overall impacts by restricting PWC use.
Visitor Experience	PWC use impacts: Negligible to minor adverse impacts on most visitors in the short and long term. Negligible to minor adverse impacts on other	PWC use impacts: Minor to moderate adverse impacts over the short and long term because of management restrictions. Negligible to minor	PWC use impacts: Negligible to minor, short- and long-term, adverse impacts on most PWC users because the most popular use areas	PWC use impacts: Moderate to major, short- and long-term, adverse impacts on PWC users no longer able to ride in the

Impact Topic	Alternative A: Continue PWC Use under a Special NPS Regulation	Alternative B: Continue PWC Use under a Special NPS Regulation with Management Restrictions	Alternative C: Continue PWC Use but Limit Area of Use and Implement Other Restrictions	No-Action Alternative — No PWC Use
	boaters due to increased congestion at popular boat launches. Negligible to minor, adverse impacts on swimmers and those visitors desiring natural quiet. Cumulative impacts: Negligible to minor, short- and long-term, adverse impacts.	impacts on other visitors (boaters, swimmers, anglers, and campers) over the short and long term. Cumulative impacts: Similar to alternative A.	still open; minor to moderate, short- and long-term, adverse impacts from increased management restrictions (limiting the number of day-use permits and reducing daily use hours or days of operation); moderate to major adverse impacts from requiring EPA emission standards to be met by 2005. Beneficial impacts on other visitors. Cumulative impacts: Negligible to minor adverse impacts over the short and long term.	national recreation area. Beneficial impact on most visitors from banning PWC use. Cumulative impacts: Beneficial as compared to alternative A. Negligible to minor adverse impacts at other waterbodies in the region as a result of PWC users going to other locations to enjoy this activity.
Visitor Conflicts and Safety	PWC use impacts: Minor to moderate, short- and long-term, adverse impacts, particularly around The Point, Buckhorn, and Guy Sandy. Negligible impacts at other locations. Cumulative impacts: Minor to moderate adverse impacts in the short and long term, particularly near high-use areas; negligible impacts elsewhere.	PWC use impacts: Similar to alternative A. Cumulative impacts: Similar to alternative A.	PWC use impacts: Beneficial impacts for swimmers and other boaters in areas where PWC use restricted. Minor to moderate, short- and long-term, adverse impacts to boaters in areas remaining open to PWC use, similar to alternative A. Cumulative impacts: Minor, short- and long-term, adverse impacts from other uses.	PWC use impacts: Beneficial impacts by reducing visitor conflicts and enhancing safety. Cumulative impacts: Minor, short- and long-term, adverse impacts from other uses.
Cultural Resources				
• Archeological Sites, Submerged Resources	PWC use impacts: Minor adverse impacts. Cumulative impacts: Minor to moderate adverse impacts due to the number of visitors and the potential for illegal collection or destruction.	PWC use impacts: Similar to alternative A, with a reduced likelihood of adverse effects in closed areas. Cumulative impacts: Same as alternative A.	PWC use impacts: Similar to alternative A, with a reduced likelihood of adverse effects in closed areas. Cumulative impacts: Same as alternative A.	PWC use impacts: Minor beneficial impacts by reducing the potential for illegal collection or damage attributable to PWC users. Cumulative impacts: Same as alternative A.
• Ethnographic Resources	PWC use impacts: No impact. Cumulative impacts: No impact.	PWC use impacts: Same as alternative A. Cumulative impacts: Same as alternative A.	PWC use impacts: Same as alternative A. Cumulative impacts: Same as alternative A.	PWC use impacts: Beneficial impact from no PWC use. Cumulative impacts: Same as alternative A.
Socioeconomic Effects	No change from current conditions. No measurable impacts on the local or regional economy.	Similar to alternative A; negligible impacts from extending the no-wake zone around the Buckhorn developed area	Potential adverse effects if PWC use decreased. No measurable impacts on the local or regional economy.	Major, short- and long-term, adverse impacts on PWC users. No measurable impacts on the local or regional economy.
National Recreation Area Management and Operations				
• Conflicts with State and Local Regulations	Negligible impacts (including cumulative impacts).	Same as alternative A.	Same as alternative A.	Same as alternative A.
• Enforcement Needs	Moderate adverse impacts on park operations (one additional permanent ranger plus funding and equipment to regulate use).	Similar to alternative A, plus educational supplies needed.	Similar to alternative A, except one permanent ranger and two part-time visitor use assistants required, along with educational supplies.	Negligible adverse impacts with no additional staff, funding, or equipment needed.

No park resources or values would be impaired by implementing any of the alternatives being considered.

CONTENTS

Purpose of and Need for Action 1
- Purpose of and Need for Action 5
- Scope of the Analysis 6
- Purpose and Significance of Chickasaw National Recreation Area 6
  - Purpose of Chickasaw National Recreation Area 6
  - Significance of Chickasaw National Recreation Area 6
- Background 7
  - NPS Organic Act and Management Policies 7
  - Summary of Available Research on the Effects of Personal Watercraft 8
  - PWC Use and Regulation at Chickasaw National Recreation Area 13
- Objectives in Taking Action 15
  - Water Quality 15
  - Air Quality 15
  - Soundscapes 15
  - Wildlife and Wildlife Habitat 15
  - Threatened, Endangered, and Special Concern Species 15
  - Shoreline Vegetation 15
  - Visitor Experience 16
  - Visitor Conflicts and Visitor Safety 16
  - Cultural Resources 16
  - Socioeconomics 16
  - National Recreation Area Management and Operations 16
- Issues and Impact Topics 16
  - Water Quality 17
  - Air Quality 17
  - Soundscapes 17
  - Wildlife and Wildlife Habitat 18
  - Threatened, Endangered, and Special Concern Species 18
  - Shoreline Vegetation 18
  - Visitor Experience 18
  - Visitor Conflicts and Visitor Safety 19
  - Cultural Resources 19
  - Socioeconomic Environment 19
  - National Recreation Area Management and Operations 19
- Issues Eliminated from Further Consideration 20
- Relationship to Other Plans, Policies, and Actions 21
  - Park Policies, Plans, and Actions 21
  - Local or State Policies, Plans, or Actions 21

Alternatives 22
- Alternative A — Continue PWC Use under a Special Regulation 22
- Alternative B — Continue PWC Use under a Special Regulation with Additional Management Restrictions (Preferred Alternative) 23
- Alternative C — Continue PWC Use under a Special Regulation but Limit Areas of Use and Implement Other Restrictions 24
- No-Action Alternative — No PWC Use 25
- The Environmentally Preferred Alternative 25

Affected Environment 48
Water Quality 48
Watershed 48
Reservoir Operation 48
Oklahoma Water Quality Standards 49
Reservoir Water Quality Data 50
Air Quality 50
Soundscapes 51
Natural and Human Noise Levels 52
Visitor Responses to PWC Noise 53
Wildlife and Wildlife Habitat 54
Mammals 54
Birds 54
Fish 54
Amphibians and Reptiles 55
Aquatic Invertebrates 55
Threatened, Endangered, or Special Concern Species 56
Wildlife Species 56
Plant Species 56
Shoreline Vegetation 57
Visitor Use and Experience 58
Annual Recreational Visitor Use 58
Monthly Visitor Use 58
Visitor Activities 59
Visitor Conflicts and Safety 62
Related Federal and State PWC Regulations 62
PWC-Related Conflicts with Other Visitors 63
Cultural Resources 63
Historical Background 64
Archeological Resources 65
Submerged Cultural Resources 65
Ethnographic Resources 65
Socioeconomic Environment 65
National Recreation Area Management and Operations 66

Environmental Consequences 67
Summary of Laws and Policies 67
General Methodology for Assessing Impacts 67
Cumulative Impacts 69
Impairment Analysis 69
PWC Use Trends 70
Water Quality 71
Guiding Regulations and Policies 71
Methodology and Assumptions 72
Impact Analysis Area 77
Impact to Water Quality from PWC Use 77
Air Quality 85
Guiding Regulations and Policies 86
Methodology and Assumptions 87
Impact Analysis Area 89

Impact to Human Health from Airborne Pollutants Related to PWC Use 89
Impact to Air Quality Related Values from PWC Pollutants 94
Soundscapes 99
Guiding Regulations and Policies 100
Methodology and Assumptions 101
Impact Analysis Area 103
Impact to Visitors from Noise Generated by Personal Watercraft 104
Wildlife and Wildlife Habitat 109
Guiding Regulations and Policies 109
Methodology and Assumptions 110
Impact Analysis Area 110
Impact of PWC Use and Noise on Wildlife and Habitat 110
Threatened, Endangered, or Special Concern Species 114
Guiding Regulations and Policies 114
Assumptions and Methodologies 115
Impact Analysis Area 116
Impact of PWC Use on Such Species 116
Shorelines and Shoreline Vegetation 119
Guiding Regulations and Policies 119
Methodology and Assumptions 119
Impact Analysis Area 120
Impact to Sensitive Shoreline Vegetation from PWC Use and Visitor Trampling 120
Visitor Experience 123
Guiding Regulations and Policies 123
Methodologies and Assumptions 124
Impact Analysis Area 125
Impact of Personal Watercraft on Visitor Experience Goals 125
Visitor Conflicts and Safety 131
Guiding Regulations and Policies 131
Methodology and Assumptions 131
Impact Analysis Area 132
Impact of PWC Use and Conflicting Uses on Visitor Safety 132
Cultural Resources 136
Guiding Regulations and Policies 136
Assumptions and Methodologies 137
Impacts on Archeological Sites and Submerged Resources 138
Impacts on Ethnographic Resources 141
Section 106 Summary 144
Socioeconomic Effects 145
Benefit-Cost Analysis 145
Costs to PWC Users 146
Costs to Local Area Businesses 147
National Recreation Area Management and Operations 147
Conflict with State and Local PWC Ordinances and Policies 147
Impact to Park Operations from Increased Enforcement Needs 149
Unavoidable Adverse Impacts 151
Loss in Long-Term Availability or Productivity to Achieve Short-Term Gain 151
Irreversible or Irretrievable Commitments of Resources 152

Consultation and Coordination 153
Consultation with American Indian Tribes 153
Consultation with Other Agencies 154

Appendix A: Superintendent's Compendium 155

Appendix B: Approach to Evaluating Surface Water Quality Impacts 158

Appendix C: Letters of Consultation 164

Glossary 169

Selected Bibliography 170

List of Preparers 179

Maps

Location 3
Alternative A: Continue PWC Use under a Special Regulation 27
Alternative B: Continue PWC Use under a Special Regulation with Additional Management Restrictions 29
Alternative C: Continue PWC Use under a Special Regulation but Limit Area of Use and Implement Other Restrictions 31
No-Action Alternative: Allow No PWC Use 33

Tables

Table 1: National PWC Registration Trend 8
Table 2: Nationwide PWC Estimates and Accident Statistics 13
Table 3: Summary of Alternatives 35
Table 4: Summary of Environmental Consequences 38
Table 5: Analysis of How Alternatives Meet Objectives 43
Table 6: State of Oklahoma Water Quality Standards for Organic Pollutants 49
Table 7: National Ambient Air Quality Standards 50
Table 8: Sound Level Comparison Chart 52
Table 9: Wildlife Known to Occur at Chickasaw National Recreation Area 55
Table 10: Federally Protected Species at Chickasaw National Recreation Area 56
Table 11: State Plant Species of Concern at Chickasaw National Recreation Area 57
Table 12: Average Annual Recreation Visitation at Chickasaw, 1979–2001 58
Table 13: Monthly Visitor Use, July 2002 59
Table 14: Annual Boat Launch Permits 61
Table 15: Oklahoma Boat Registration Statistics, 1996–2001 70
Table 16: Ecotoxicological and Human Health Benchmarks for Organic Pollutants 73
Table 17: Estimated EPA Reductions in Watercraft Emissions 74
Table 18: Estimated Water Volumes (acre-feet) 75
Table 19: Peak-Day Motorized Watercraft Use, Chickasaw National Recreation Area, 2002 – 2012 76
Table 20: Threshold Water Volumes Needed to Dilute PWC Emissions, Alternative A 78

Table 21: Threshold Water Volumes Needed to Dilute PWC and Motorized Boat Emissions, Alternative A 79
Table 22: Threshold Water Volumes Needed to Dilute PWC Emissions, Alternative B 81
Table 23: Threshold Water Volumes Needed to Dilute PWC and Motorized Boat Emissions, Alternative B 81
Table 24: Threshold Water Volumes Needed to Dilute PWC Emissions, Alternative C 83
Table 25: Threshold Water Volumes Needed to Dilute PWC and Motorized Boat Emissions, Alternative C 83
Table 26: Threshold Water Volumes Needed to Dilute Motorized Boat Emissions, No-Action Alternative 85
Table 27: PWC Emissions and Human Health Impact Levels, Alternative A 90
Table 28: PWC and Motorized Boat Emissions and Human Health Impact Levels, Alternative A 90
Table 29: PWC Emissions and Human Health Impact Levels, Alternative B 91
Table 30: PWC and Motorized Boat Emissions and Human Health Impact Levels, Alternative B 91
Table 31 : PWC Emissions and Human Health Impact Levels, Alternative C 92
Table 32: PWC and Motorized Boat Emissions and Human Health Impact Levels, Alternative C 93
Table 33: Motorized Boat Emissions and Human Health Impact Levels, No-Action Alternative 93
Table 34: Air Quality Related Impacts from PWC Emissions, Alternative A 95
Table 35: Air Quality Related Impacts from PWC and Motorized Boat Emissions, Alternative A 96
Table 36: Air Quality Related Impacts from PWC Emissions, Alternative B 96
Table 37: Air Quality Related Impacts from PWC and Motorized Boat Emissions, Alternative B 97
Table 38: Air Quality Related Impacts from PWC Emissions, Alternative C 98
Table 39: Air Quality Related Impacts from PWC and Motorized Boat Emissions, Alternative C 98
Table 40: Air Quality Related Impacts from PWC and Motorized Boat Emissions, No-Action Alternative 99

Purpose of and Need for Action

Chickasaw National Recreation Area was originally established as Sulphur Springs Reservation by Congress in 1902 near Sulphur, Oklahoma. The reservation was enlarged slightly in 1906 and renamed Platt National Park to provide for the protection of its unique recreational, cultural and natural resources, including springs, streams, lakes, hiking trails and historic structures. Lake of the Arbuckles was created in 1967 as a public water supply reservoir. On March 17, 1976, it was combined with Arbuckle Recreation Area to create the Chickasaw National Recreation Area, a unit of the national park system. The goal of the national recreation area is to provide each visitor with an educational, enjoyable, safe, and memorable experience. Chickasaw is located on U.S. Highway 177, just south of the town of Sulphur, Oklahoma, and approximately 90 miles south of Oklahoma City.

More than one million personal watercraft (PWC)[*] are estimated to be in operation today in the United States. Sometimes referred to as "Jet Skis" or "Wet Bikes," these vessels use an inboard, internal combustion engine powering a water jet pump as its primary source of propulsion. They are used for enjoyment, particularly for touring and maneuvers such as wave jumping, and they are capable of speeds in the 60-mph range.

The National Park Service (NPS) maintains that personal watercraft emerged and gained popularity in park units before it could initiate and complete a "full evaluation of the possible impacts and ramifications." While PWC use remains a relatively new recreational activity, it has occurred in 32 of the 87 park units that allow motorized boating.

The National Park Service first began to study PWC use in Everglades National Park. The studies showed that PWC use over emergent vegetation, shallow grass flats, and mud flats commonly used by feeding shorebirds damaged the vegetation, adversely impacted the shorebirds, and disturbed the life cycles of other wildlife. Consequently, managers at Everglades determined that PWC use remained inconsistent with the resources, values, and purposes for which the park was established. In 1994 the NPS prohibited PWC use by a special regulation at the park (59 FR 58781).

Other public entities have taken steps to limit and even to ban PWC use in certain waterways as national researchers study more about the effects of PWC use. At least 34 states have either implemented or have considered regulating the use and operation of personal watercraft (63 FR 49314). Similarly, various federal agencies, including the U.S. Fish and Wildlife Service and the National Oceanic and Atmospheric Administration, have managed personal watercraft differently than other classes of motorized watercraft.

Specifically, the National Oceanic and Atmospheric Administration regulates PWC use in most national marine sanctuaries. The regulation resulted in a court case where the Court of Appeals for the District of Columbia declared such PWC-specific management valid. In *Personal Watercraft Industry Association v. Department of Commerce*, 48 F.3d 540 (D. C. Cir. 1995), the court ruled that an agency can discriminate and manage one type of vessel (specifically personal watercraft) differently than other vessels if the agency explains its reasons for the differentiation.

---

[*] Personal watercraft, as defined in 36 CFR 1.4(a) (2000), refers to a vessel, usually less than 16 feet in length, which uses an inboard, internal combustion engine powering a water jet pump as its primary source of propulsion. The vessel is intended to be operated by a person or persons sitting, standing, or kneeling on the vessel, rather than within the confines of the hull. The length is measured from end to end over the deck excluding sheer, meaning a straight line measurement of the overall length from the foremost part of the vessel to the aftermost part of the vessel, measured parallel to the centerline. Bow sprits, bumpkins, rudders, outboard motor brackets, and similar fittings or attachments, are not included in the measurement. Length is stated in feet and inches.

In February 1997, the Tahoe Regional Planning Agency (TRPA), the governing body charged with ensuring no derogation of Lake Tahoe's water quality, voted unanimously to ban all carbureted two-stroke, internal combustion engines, including personal watercraft, because of their effects on water quality. Lake Tahoe's ban began in 2000.

In July 1998, the Washington State Supreme Court in *Weden v. San Juan County* (135 Wash. 2d 678 [1998]) found that the county had the authority to ban the use of personal watercraft as a proper use of its police power in order to protect the public health, safety, or general welfare. Further, personal watercraft are different from other vessels, and Washington counties have the authority to treat them differently.

In recognition of its duties under its Organic Act and its *Management Policies,* as well as increased awareness and public controversy, the National Park Service reevaluated its methods of PWC regulation. Historically, the National Park Service had grouped personal watercraft with all vessels; thus, people could use personal watercraft when the superintendent's compendium allowed the use of other vessels. Later the Park Service closed seven units to PWC use through the implementation of horsepower restrictions, general management plan revisions, and park-specific regulations such as those promulgated by Everglades National Park.

In May 1998 the Bluewater Network, a private, independent, nonprofit organization, filed a petition urging the National Park Service to initiate the rulemaking process to prohibit PWC use throughout the national park system. In response to the petition, the Park Service issued an interim management policy requiring superintendents of parks where PWC use can occur but where the use had never occurred to close the unit to such use until the rule was finalized. In addition, the National Park Service proposed a specific regulation premised on the notion that personal watercraft differ from conventional watercraft in terms of design, use, safety record, controversy, visitor impacts, resource impacts, horsepower to vessel length ratio, and thrust capacity (63 FR 178 [Sept. 15, 1998]: 49312–17).

The National Park Service envisioned the servicewide regulation as an opportunity to evaluate impacts from PWC use before authorizing the use. The preamble to the servicewide regulation calls the regulation a "conservative approach to managing PWC use" considering the resource concerns, visitor conflicts, visitor enjoyment, and visitor safety. During a 60-day comment period the National Park Service received nearly 20,000 comments.

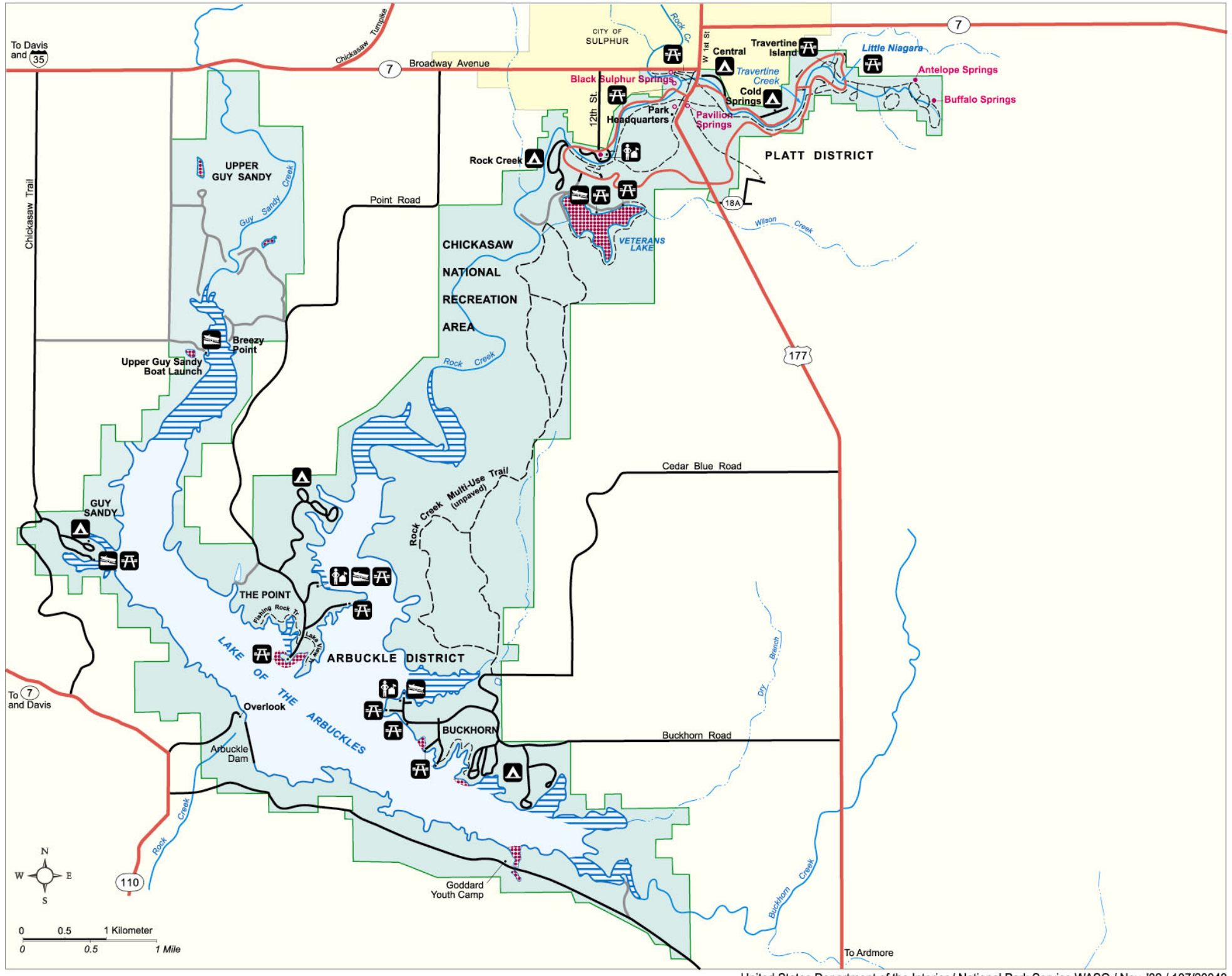
As a result of public comments and further review, the National Park Service promulgated an amended regulation that prohibited PWC use in most units and required the remaining units to determine the appropriateness of continued PWC use (36 CFR 3.24(a), 2000); 65 FR 55 [Mar. 21, 2000]: 15077–90). Specifically, the regulation allowed the NPS to designate PWC use areas and to continue their use by promulgating a special regulation in 11 units and by amending the superintendent's compendium in 10 units (36 CFR 3.24(b), 2000). The National Park Service based the distinction between designation methods on the unit's degree of motorized watercraft use.

In response to the PWC final regulation, Bluewater Network sued the National Park Service under the Administrative Procedures Act and the NPS Organic Act. The organization challenged the National Park Service's decision to allow continued PWC use in 21 units while prohibiting PWC use in other units. In addition, the organization also disputed the agency's decision to allow 10 units to continue PWC use after 2002 by making entries in superintendents' compendiums, which would not require the opportunity for public input through a notice and comments on the rulemaking process. Further, the environmental group claimed that because PWC use causes water and air pollution, generates increased noise levels, and poses public safety threats, the National Park Service acted arbitrarily and capriciously when making the challenged decisions.

Chickasaw National Recreation Area

Oklahoma

Location



United States Department of the Interior / National Park Service WASO / Nov. '02 / 107/20043

Campground
Boat ramp
Open water
Hiking Trail
Ranger station
Picnic area
Controlled area (no wake)
Fresh water spring
PWC exclusion area
Mineral water spring

Blank – back of map

In response to the suit, the National Park Service and the environmental group negotiated a settlement. The resulting settlement agreement, signed by the judge on April 12, 2001, changed portions of the National Park Service's PWC rule. While 21 units could continue PWC use in the short term, each of those parks desiring to continue long-term PWC use was to promulgate a park-specific special regulation in 2002. In addition, the settlement stipulates that the National Park Service must base its decision to issue a park-specific special regulation to continue PWC use through an environmental analysis conducted in accordance with the National Environmental Policy Act (NEPA). The NEPA analysis at a minimum, according to the settlement, must evaluate PWC impacts on water quality, air quality, soundscapes, wildlife, wildlife habitat, shoreline vegetation, visitor conflicts, and visitor safety.

In 2001 the National Park Service adopted its new management policy for personal watercraft. The policy prohibits PWC use in national park system units unless their use remains appropriate for the specific park unit (*Management Policies 2001,* sec. 8.2.3.3). The policy statement authorizes the use based on the park's enabling legislation, resources, values, other park uses, and overall management strategies.

As the settlement deadline approached and the park units were preparing to prohibit PWC use, the National Park Service, Congress, and PWC user groups sought legal methods to keep the parks open to this activity. However, no method was successful. On April 22, 2002, the following units closed for PWC use: Assateague Island National Seashore; Big Thicket National Preserve; Pictured Rocks National Lakeshore; Fire Island National Seashore; and Gateway National Recreation Area. On September 15, 2002, eight other park units were scheduled to close to PWC use, including Chickasaw National Recreation Area.

The proposed September 16, 2002, prohibition of personal watercraft was averted with the execution of a stipulated modification to the settlement agreement. The modified settlement agreement was approved by the court on September 9, 2002, and extended unrestricted personal watercraft use in selected national park system units, including Chickasaw, until November 6, 2002. Park units that prepare an environmental assessment to analyze PWC use alternatives and then select an alternative to continue such use will have to draft a special regulation to authorize that use in the future.

PURPOSE OF AND NEED FOR ACTION

The purpose of and the need for taking action is to evaluate a range of alternatives and strategies for managing PWC use at Chickasaw in order to ensure the protection of park resources and values while offering recreational opportunities as provided for in the national recreation area's enabling legislation, purpose, mission, and goals. Upon completion of the NEPA process, the National Park Service may either take action to adopt special regulations to manage PWC use at this park unit, or it may discontinue PWC use, as allowed for in the March 2000 rule.

This environmental assessment evaluates four alternatives concerning the use of personal watercraft at Chickasaw. The alternatives include:

- *Alternative A* — Continue PWC use under a special NPS regulation.
- *Alternative B* — Continue PWC use under a special regulation with additional management prescriptions.
- *Alternative C* — Continue PWC use under a special regulation but limit area of use and implement other restrictions.
- *No-Action Alternative* — Eliminate PWC use entirely.

SCOPE OF THE ANALYSIS

Motorboats and other watercraft have been used in Chickasaw since 1966; personal watercraft have been used at Chickasaw since their introduction in the 1980s. While some effects of PWC use are similar to other motorcraft and therefore difficult to distinguish, the focus of this action is in support of decisions and rulemaking specific to PWC use. However, while the settlement agreement and the need for action have defined the scope of this environmental assessment, the National Environmental Policy Act requires an analysis of cumulative effects on resources of all past, present, and reasonably foreseeable actions when added to the effects of the proposal (40 CFR 1508.7, 2000). The scope of this analysis, therefore, is to define management alternatives specific to PWC use, in consideration of other uses, actions, and activities cumulatively affecting park resources and values.

PURPOSE AND SIGNIFICANCE OF CHICKASAW NATIONAL RECREATION AREA

Congress establishes national park system units to fulfill specified purposes, based on a park's unique and significant resources. A park's purpose, as established by Congress, is the fundamental building block for its decisions to conserve resources while providing for "enjoyment of future generations."

PURPOSE OF CHICKASAW NATIONAL RECREATION AREA

The purpose of the park is addressed in the following statements that are excerpts from the park's *Strategic Plan.* The laws establishing Chickasaw provided for the National Park Service to:

- Provide for the proper utilization and control of springs and waters of its creeks.
- Provide for efficient administration of other adjacent areas containing scenic, scientific, natural, and historic values.
- Provide public outdoor recreation use and enjoyment of Arbuckle Reservoir.
- Permit hunting and fishing in some areas.

Therefore, the purpose of Chickasaw is the protection of springs and waters; the preservation of sites of archeological or ethnological interest; the provision of outdoor recreation; the administration of scenic, scientific, natural, and historic values; the memorialization of the Chickasaw Indian Nation; and the provision for hunting and fishing.

SIGNIFICANCE OF CHICKASAW NATIONAL RECREATION AREA

The significance of Chickasaw stems from the following resources and values of the park:

- the availability of both mineral and fresh water, which come from one of the most complex geological and hydrological features in the United States and man's use of this resource
- the presence of the cultural landscape of Platt Historic District, which reflects the era of 1933–1940 when the Civilian Conservation Corp (CCC) implemented NPS "rustic" designs
- the availability of recreational opportunities for visitors to experience a wide range of outdoor experiences — swimming, boating, fishing, hiking, observing nature, hunting, camping, biking, horseback riding, family reunions, and picnicking — reminding us of the rural character in the history of the American people

- the presence of a transition zone where the eastern deciduous forest and the western prairies meet, which is unique to the central part of the United States.

The park's mission statement is as follows:

> Chickasaw National Recreation Area exists as a part of the National Park Service system to provide for the protection of the park's unique resources, springs, streams, lakes, and other natural features, and its cultural history, landscapes, and structures, as well as its recreational resources and to provide for public education, appreciation, and recreational use and enjoyment of these resources. We will strive to give each visitor an enjoyable, educational, and memorable experience.

BACKGROUND

NPS ORGANIC ACT AND MANAGEMENT POLICIES

By enacting the National Park Service Organic Act of 1916, Congress directed the National Park Service to manage units under its jurisdiction "to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations" (16 USC 1). Congress reiterated this mandate in the Redwood National Park Expansion Act of 1978 by stating that the National Park Service must conduct its actions in a manner that will ensure no "derogation of the values and purposes for which these various areas have been established, except as may have been or shall be directly and specifically provided by Congress" (16 USC 1 a-1).

Despite these mandates, the Organic Act and its amendments afford the National Park Service latitude when making resource decisions that balance visitor recreation and resource preservation. By these acts Congress "empowered [the National Park Service] with the authority to determine what uses of park resources are proper and what proportion of the parks resources are available for each use" (*Bicycle Trails Council of Marin v. Babbitt,* 82 F.3d 1445, 1453 (9th Cir. 1996)).

Yet, courts have consistently interpreted the Organic Act and its amendments to elevate resource conservation above visitor recreation. *Michigan United Conservation Clubs v. Lujan,* 949 F.2d 202, 206 (6th Cir. 1991) states, "Congress placed specific emphasis on conservation." The *National Rifle Ass'n of America v. Potter,* 628 F.Supp. 903, 909 (D.D.C. 1986) states, "In the Organic Act Congress speaks of but a single purpose, namely, conservation." The NPS *Management Policies* also recognize that resource conservation takes precedence over visitor recreation. The policy dictates "when there is a conflict between conserving resources and values and providing for enjoyment of them, conservation is to be predominant" (NPS *Management Policies 2001,* sec. 1.4.3).

Because conservation remains predominant, the National Park Service seeks to avoid or to minimize adverse impacts on park resources and values. Yet, the Park Service has discretion to allow negative impacts when necessary (NPS *Management Policies 2001,* sec. 1.4.3). While some actions and activities cause impacts, the National Park Service cannot allow an adverse impact that constitutes a resource impairment (*Management Policies,* sec. 1.4.3). The Organic Act prohibits actions that permanently impair park resources unless a law directly and specifically allows for the acts (16 USC 1 a-1). An action constitutes an impairment when its impacts "harm the integrity of park resources or values, including the opportunities that otherwise would be present for the enjoyment of those resources or values" (*Management Policies,* sec. 1.4.4). To determine impairment, the National Park Service must evaluate "the particular resources and values that would be affected; the severity, duration, and timing of the impact; the direct and indirect effects of the impact; and the cumulative effects of the impact in question and other impacts" (*Management Policies,* sec. 1.4.4).

Because park units vary based on their enabling legislation, natural resources, cultural resources, and missions, the recreational activities appropriate for each unit and for areas within each unit vary as well. An action appropriate in one unit could impair resources in another unit. Thus, this environmental assessment analyzes the context, duration, and intensity of impacts related to PWC use at Chickasaw, as well as the potential for resource impairment, as required by *Director's Order #12: Conservation Planning, Environmental Impact Analysis and Decision-making* (DO #12).

SUMMARY OF AVAILABLE RESEARCH ON THE EFFECTS OF PERSONAL WATERCRAFT

Over the past two decades PWC use in the United States increased dramatically. However, there are conflicting data about whether PWC use is continuing to increase. While the National Transportation Safety Board (NTSB) estimates that retailers sell approximately 200,000 personal watercraft each year and people currently use another 1 million (NTSB 1998), the PWC industry argues that PWC sales have decreased by 50% from 1995 to 2000 (American Watercraft Association [AWA] 2001). National PWC ownership increased every year between 1991 and 1998; the rate of annual increase peaked in 1994 at 32% and dropped slightly in 1999, 2000, and 2001 (see Table 1).

TABLE 1: NATIONAL PWC REGISTRATION TREND

Year	No. of Boats Owned	Boat Ownership Trend (Percentage Change)	No. of Personal Watercraft Owned	PWC Ownership Trend (Percentage Change)
1991	16,262,000	--	305,915	--
1992	16,262,000	0%	372,283	21.7%
1993	16,212,000	0%	454,545	22.1%
1994	16,239,000	0%	600,000	32.0%
1995	15,375,000	-5%	760,000	26.7%
1996	15,830,000	3%	900,000	18.4%
1997	16,230,000	3%	1,000,000	11.1%
1998	16,657,000	3%	1,100,000	10.0%
1999	16,773,000	1%	1,096,000	-0.4%
2000	16,965,000	1%	1,078,400	-1.6%
2001			1,053,560	-2.4%

SOURCES: M. Schmidt, USCG, e-mail comm. for boat numbers, Sept. 4, 2001; National Marine Manufacturers Association (NMMA) for PWC numbers, 2002.

The majority of personal watercraft used today are powered by conventional two-stroke, carbureted engines (NPS 1998a; California Air Resources Board [CARB] 1999). However, multiple studies have demonstrated that four-stroke engines are substantially cleaner than two-stroke, carbureted engines, generating approximately 90% fewer emissions (British Columbia Ministry of Water, Land and Air Protection 1993; Oregon Department of Environmental Quality [ODEQ] 1999; TRPA 1999). PWIA notes that direct-injection engines have been available in personal watercraft for four years; and three PWC manufacturers introduced four-stroke engines for the 2002 model year (PWIA to NPS, May 28, 2002, comment on the *Lake Mead National Recreation Area Lake Management Plan and Draft Environmental Impact Statement).* The U.S. Environmental Protection Agency assumes that the existing two-stroke engines would not be completely replaced by newer PWC technology until 2050 (40 CFR 89, 90, 91).

The average operating life of a personal watercraft is 5 to 10 years, depending on the source. The formula for determining the operating life of personal watercraft was published in the *Federal Register* on October 4, 1996 (US EPA 1996a). Based on this formula, the National Park Service expects that by 2012 most boat owners will already be in compliance with the 2006 EPA marine engine standards. The Personal Watercraft Industry Association believes that the typical operating life of a personal watercraft rental is 3 years and of a privately owned vessel approximately 5 to 7 years (PWIA to NPS, May 28, 2002, comment

on *Lake Mead National Recreation Area Lake Management Plan and Draft Environmental Impact Statement*).

Environmental groups, PWC users and manufacturers, and land managers express differing opinions about the environmental consequences of PWC use, and about the need to manage or to limit this recreational activity. Research conducted by various sources on the effects of PWC use is summarized below for water pollution, air pollution, noise, wildlife, vegetation and shoreline erosion, and health and safety.

Water Pollution

Two-stroke, carbureted engines discharge as much as 30% of their fuel unburned directly into the water (NPS 1999; CARB 1999). Hydrocarbons, including benzene, toluene, ethylbenzene, and xylene (BTEX) and polyaromatic hydrocarbons (PAHs), are also released, as well as methyl tertiary-butyl ether (MTBE) in states that use this additive. The amount of pollution correctly attributed to PWC use compared to other motorboats and the degree to which PWC use affects water quality remains debatable. As noted in a report by the Oregon Department of Environmental Quality, every waterbody has different conditions (e.g., water temperature, air temperatures, water mixing, motorboating use, and winds) that affect the pollutants' impacts (ODEQ 1999).

A recent study conducted by the California Air Resources Board consisted of a laboratory test designed to comparatively evaluate exhaust emissions from marine and PWC engines, in particular two- and four-stroke engines (CARB 2001). The results of this study showed a difference in emissions (in some cases 10 times higher total hydrocarbons in two-stroke engines) between these two types of engines. An exception was air emissions of NO_x, which was higher in four-stroke than in two-stroke engines. Concentrations of pollutants (MTBE, BTEX) in the tested water were consistently higher for two-stroke engines.

In 1996 the Environmental Protection Agency promulgated a rule to control exhaust emissions from new marine engines, including outboard motors and personal watercraft (US EPA 1996a). As a result of the rule, the Environmental Protection Agency estimated an overall 52% reduction in hydrocarbon emissions from marine engines from present levels by 2010, and a 75% reduction by 2030, based on converting polluting machines. The 1997 EPA rule delayed implementation by one year (US EPA 1996a, 1997).

Discharges of MTBE and PAHs particularly concern scientists because of their potential to adversely affect the health of people and aquatic organisms. Scientists need to conduct additional studies on PAHs (Allen et al. 1998) and on MTBE (NPS 1999), as well as long-term studies on the effect of repeated exposure to low levels of these pollutants (Asplund 2001).

At Lake Tahoe concern about the negative impact on lake water quality and aquatic life caused by the use of two-stroke marine engines led to at least 10 different studies relevant to motorized watercraft in the Tahoe Basin in 1997 and 1998. The results of these studies (Allen et al. 1998) confirmed that (1) petroleum products are in the lakes as a result of motorized watercraft operation, and (2) watercraft powered by carbureted two-stroke engines discharge pollutants at an order of magnitude greater than do watercraft powered by newer technology engines (TRPA 1999).

On June 25, 1997, the Tahoe Regional Planning Agency adopted an ordinance prohibiting the "discharge of unburned fuel and oil from the operation of watercraft propelled by carbureted two-stroke engines" beginning June 1, 1999. Following the release of an environmental assessment in January 1999, this prohibition was made permanent.

PAHs (which include benzo(a)pyrene, naphthalene, and 1-methyl naphthalene) are released during the combustion of fuel, although some PAHs are also found in unburned gasoline. PAHs, as well as other hydrocarbon emissions, could potentially be reduced as new four-stroke and direct-injection engines replace older carbureted two-stroke engines. The conversion of carbureted two-stroke engines would be an important step toward substantially reducing petroleum-related pollutants.

Some research shows that PAHs, including those from PWC emissions, adversely affect water quality by means of harmful phototoxic effects on ecologically sensitive plankton and other small water organisms (US EPA 1998; Oris et al. 1998; Landrum et al. 1987; Mekenyan et al. 1994; Arfsten et al. 1996). This in turn can affect aquatic life and ultimately aquatic food chains. The primary concern is in shallow water ecosystems.

Air Pollution

Personal watercraft emit various compounds that that may adversely affect air quality. In two-stroke engines commonly used in personal watercraft the fuel oil is used once and is expelled as part of the exhaust; and the combustion process results in emissions of air pollutants such as nitrogen oxides (NO_x), volatile organic compounds (VOC), particulate matter (PM), and carbon monoxide (CO). In areas with high PWC use some air quality degradation likely occurs (US EPA 1996a, 2000). Kado et al. (2000) found that two-stroke engines had considerably higher emissions of airborne particulates and PAHs than four-stroke engines tested. Changing from two-stroke, carbureted engines to two-stroke direct-injected engines may result in increases of airborne-particulate associated PAHs (Kado et al. 2000). Further research is needed to identify what impact this would have on PAH concentrations in water. It is assumed that the 1996 EPA rule concerning marine engines will substantially reduce air emissions from personal watercraft in the future (US EPA 1996a).

In August 2002 the U.S. Environmental Protection Agency proposed additional rules that would further reduce boating emissions. The proposal includes evaporative emission standards for all boats and would reduce emissions from fuel tanks, etc., by 80% (67 FR 157 [Aug. 14, 2002]: 53049–115).

Noise

Noise levels emitted by PWC engines vary from vessel to vessel, depending on many factors. No literature was found that definitively described scientific measurements of PWC noise. Some PWC industry literature states that all recently manufactured watercraft emit fewer than 80 decibels (dB) at 50 feet from the vessel, whereas some literature from public interest groups attribute levels as high as 102 dB without specifying distance. None of this literature adequately describes the methodology for collecting the data to determine those levels. Because of this, the National Park Service contracted noise measurements of personal watercraft and other boat types in 2001 at Glen Canyon National Recreation Area; preliminary analysis of this data indicates maximum levels for PWC-generated noise at 82 feet (25 meters) of approximately 68 to 78 A-weighted dB (dBA). Other motorboat types were measured during that study at approximately 65 to 86 dBA at 82 feet (Harris Miller Miller & Hanson, Inc., 2002).

Regulations for boating and water use activities established by the National Park Service prohibit vessels from operating at more than 82 dB measured at 82 feet (25 meters) from the vessel (36 CFR 3.7). However, this regulation does not imply that there are no noise impacts from vessels operating below that limit. Noise impacts from PWC use are caused by a number of factors. Noise from human sources, including personal watercraft, can intrude on natural soundscapes, masking the natural sounds that are an intrinsic part of the environment. This can be especially true in quiet places, such as in secluded lakes,

coves, river corridors, and backwater areas. Also, PWC use in areas where there are nonmotorized users (such as canoeists, sailors, people fishing or picnicking, and kayakers) can disrupt the "passive" experience of park resources and values.

Komanoff and Shaw (2000) note that the biggest difference between noise from personal watercraft and that from motorboats is that the former continually leave the water, which magnifies noise in two ways. Without the muffling effect of water, the engine noise is typically 15 dBA louder and the smacking of the craft against the water surface results in a loud "whoop" or series of them. With the rapid maneuvering and frequent speed changes, the impeller has no constant "throughput" and no consistent load on the engine. Consequently, the engine speed rises and falls, resulting in a variable pitch. This constantly changing noise is often perceived as more disturbing than the constant noise from motorboats.

PWC users tend to operate close to shore, to operate in confined areas, and to travel in groups, making noise more noticeable to other recreationists. Motorboats traveling back and forth in one area at open throttle or spinning around in small inlets also generate complaints about noise levels; however, most motorboats tend to operate away from shore and to navigate in a straight line, thus being less noticeable to other recreationists (Vlasich 1998).

Research conducted by the Izaak Walton League (IWL) indicates that one PWC unit can emit between 85 and 105 dB of sound, and that wildlife or humans located 100 feet away may hear sounds of 75 dB. This study also stated that rapid changes in acceleration and direction may create a greater disturbance and emit sounds of up to 90 dB (IWL 1999). Other studies conducted by the New Jersey State Police indicate that a PWC unit with a 100-horsepower (hp) engine emits up to 76 dBA, while a single, 175-hp outboard engine emits up to 81 dBA. The Personal Watercraft Industry Association (PWIA) believes that through the year 2002, most PWC output is between 155 and 165 hp (PWIA e-mail to NPS, Sept. 23, 2002).

Sea-Doo research indicates that in three out of five distances measured during a sound level test, PWC engines were quieter than an outboard motorboat. Sea-Doo also found that it would take approximately four personal watercraft operating 50 feet from shore to produce 77 dBA, and it would take 16 personal watercraft operating 15 feet from shore to emit 83 dBA of sound, which is equal to one open exhaust boat at 1,600 feet from the shore. In response to public complaints, the PWC industry has employed new technologies to reduce sound by about 50% to 70% on 1999 and newer models (Sea-Doo 2000; Hayes 2002). Additionally, by 2006 the EPA requirements will reduce PWC noise, in association with improvements to engine technology (US EPA 1996b). EPA research also indicated that one PWC unit operating 50 feet from an onshore observer emits a sound level of 71 dBA, and studies conducted using the Society of Automotive Engineers (2001) found that two PWC units operating 50 feet from the shore emit similar sound levels of about 74 dBA (PWIA 2000).

Most studies on the effects of noise on soundscapes and human receptors have focused on highway and airport noise. Komanoff and Shaw (2000) used the analytical approaches of these studies to perform a noise-cost analysis of personal watercraft. They concluded that the cost to beachgoers from PWC noise was more than $900 million per year. The cost per personal watercraft was estimated to be about $700 per vessel each year or $47 for each three-hour "personal watercraft day." They further concluded that the cost per beachgoer was the highest at secluded lake sites, where beachgoers had a higher expectation of experiencing natural quiet and usually invested a larger amount of time and personal energy in reaching the area. However, because there are many more visitors to be affected at popular beaches, noise costs per personal watercraft were highest at crowded sites (*Drowning in Noise: Noise Costs of Jet Skis in America* [Komanoff and Shaw 2000]).

Wildlife Impacts

Although relatively few studies have specifically examined PWC effects on wildlife, several researchers have documented wildlife disturbances from personal watercraft and motorboats. A study recently completed in Florida examined the distance at which waterbirds are disturbed by both personal watercraft and outboard-powered boats (Rodgers and Schwikert 2002). Flush distances varied from 65 to 160 feet for personal watercraft, and flush distances for most species were greater for motorboats than for personal watercraft 80% of the time. The authors note that PWC use may be more threatening to waterbirds since PWC users can navigate in shallow secluded waterways where birds typically eat and rest. Burger (2000) examined the behavior of common terns in relation to PWC use and other boats and noted that PWC users traveled faster and came closer to banks, resulting in more flight response in terns and contributing to lower reproductive success.

Shoreline Vegetation

The effects of PWC use on aquatic communities have not been fully studied, and scientists disagree about whether PWC use adversely impacts aquatic vegetation. Most of the concern arises from the shallow draft of personal watercraft, which allows access to shallow areas that conventional motorboats cannot reach. Like other vessels, personal watercraft may destroy grasses that occur in shallow water ecosystems. Anderson (2000) studied the effect of PWC wave-wash on shallow salt marsh vegetation and found that although the waves from personal watercraft are not different from those generated by other boats, personal watercraft can enter marsh channels and create sediment suspension problems in these areas.

Erosion Effects

Some studies have examined the erosion effects of waves generated by personal watercraft, and other studies suggest that personal watercraft may disturb sediments on river or lake bottoms and cause turbidity. Conflicting research exists concerning whether PWC-caused waves result in erosion and sedimentation. PWC-generated waves vary in size depending on the environment, including weight of the driver, number of passengers, and speed. Anderson (2000) studied the effect of PWC wave-wash on shallow salt marsh vegetation and found that although the waves from personal watercraft are not different from those generated by other boats, personal watercraft can enter marsh channels and create sediment suspension problems in these areas.

Health and Safety Concerns

Industry representatives report that PWC accidents decreased in some states in the late 1990s. The National Transportation Safety Board reported that in 1996 personal watercraft represented 7.5% of state-registered recreational boats but accounted for 36% of recreational boating accidents (NTSB 1998). In the same year PWC operators accounted for more than 41% of people injured in boating accidents. PWC operators accounted for approximately 85% of the persons injured in accidents studied in 1997 (NTSB 1998).

Increased PWC use in recent years has resulted in more concern about the health and safety of operators, swimmers, snorkelers, divers, and other boaters. A 1998 NTSB study revealed that while recreational boating fatalities have been declining in recent years, PWC-related fatalities have increased (NTSB 1998). Nationwide PWC accident statistics provided by the U.S. Coast Guard support the increase in PWC-related fatalities (see Table 2). However, since a peak of 84 PWC-related fatalities in 1997,

accidents, injuries, and fatalities involving personal watercraft have decreased (M. Schmidt, U.S. Coast Guard [USCG], pers. comm., Sept. 4, 2001). The U.S. Coast Guard's Office of Boating Safety studied exposure data to assess boating risks. This method allows for a comparison between boat types based on comparable time in the water. PWC use ranked second in boat type for fatalities per million hours of exposure in 1998, with a 0.24 death rate per million exposure hours.

TABLE 2: NATIONWIDE PWC ESTIMATES AND ACCIDENT STATISTICS

Year	Recreational Boats Owned*	PWC Owned*	No. of PWC in Accidents	No. of PWC Injuries	No. of PWC Fatalities	No. of All Boats Involved in Accidents	Percentage of PWC Involved in Accidents
1987	14,515,000	N/A	376	156	5	9,020	4.2
1988	15,093,000	N/A	650	254	20	8,981	7.2
1989	15,658,000	N/A	844	402	20	8,020	10.5
1990	15,987,000	N/A	1,162	532	28	8,591	13.5
1991	16,262,000	305,915	1,513	708	26	8,821	17.2
1992	16,262,000	372,283	1,650	730	34	8,206	20.1
1993	16,212,000	454,545	2,236	915	35	8,689	25.7
1994	16,239,000	600,000	3,002	1,338	56	9,722	30.9
1995	15,375,000	760,000	3,986	1,617	68	11,534	34.6
1996	15,830,000	900,000	4,099	1,837	57	11,306	36.3
1997	16,230,000	1,000,000	4,070	1,812	84	11,399	35.7
1998	16,657,000	1,100,000	3,607	1,743	78	11,368	31.7
1999	16,773,000	1,096,000	3,374	1,614	66	11,190	30.2
2000	16,965,000	1,078,400	3,282	1,580	68	11,079	29.6
Total			**33,851**	**15,238**	**645**		

SOURCE: M. Schmidt, USCG, e-mail comm., Sept. 4, 2001.
*Estimates provided by the NMMA (M. Schmidt, USCG, pers. comm., Sept. 4, 2001).
N/A: Not available.

Since PWC operators can be as young as 12 in several states, accidents can involve children. The American Academy of Pediatrics (2000) recommends that no one younger than 16 operate personal watercraft.

Some manufacturing changes on throttle and steering may reduce potential accidents. For example, on more recent models, Sea-Doo developed an off-power assisted steering system that helps steer during off-power as well as off-throttle situations. This system, according to company literature, is designed to provide additional maneuverability and improve the rate of deceleration (Sea-Doo 2001a).

PWC USE AND REGULATION AT CHICKASAW NATIONAL RECREATION AREA

Visitation at Chickasaw has remained relatively stable the last three years, with an average of 3 million visitors annually, including traffic passing through the park on U.S. Highway 177. Approximately 1.5 million visitors annually use the recreation area's facilities, including visitors pursuing recreational activities on the reservoir and those engaging in other recreational opportunities. Based on ranger observations, most PWC users are from the immediate region; within a radius of about 200 miles are Oklahoma City and the Dallas/Fort Worth area, with a population of about 5.5 million.

The majority of PWC use occurs primarily from April through September, although PWC users may be on the lake year-round. PWC users spend an average of four hours on the lake.

Volume of PWC Use

The park began counting personal watercraft in 1996, and through the end of June 2001 approximately 1,820 PWC had been counted in the park (on a cumulative basis), compared to about 7,150 boats (R. Shireman, NPS pers. comm., D. Jones, URS, Aug. 13, 2002). Based on the number of annual launch ramp permits issued, PWC use declined from 1997 to 2000 (see discussion on page 61). In addition to annual permits, day use permits are also issued. These do not specify the type of boat being used and, based on staff observations, the percent of PWC entering the lake is higher for day use permits during the warm weather season (R. Shireman, NPS pers. comm., D. Jones, URS, August 13, 2002). On busy summer weekends in 2001 and 2002, park staff observed between 34 and 94 personal watercraft per day in the recreation area.

According to park records, approximately 59 personal watercraft per day were observed during the midweek July 4, 2002, holiday period (Wednesday through Friday). Approximately 114 personal watercraft per day were observed on Saturday and Sunday during that holiday weekend (NPS 2002c).

PWC Use Areas

Lake of the Arbuckles is the only lake in Chickasaw open to PWC use; the "Superintendent's Compendium" (see appendix A) has closed all lakes of 100 acres or less to PWC use, including Veterans Lake (67 acres). The central part of the main body of the lake is a high-use area for personal watercraft. Other high-use areas include in front of The Point and all along the Buckhorn area near picnic areas and campgrounds (see Location map). About 98% of motorcraft operators launch at Buckhorn, The Point, and Guy Sandy; there is also a small ramp at Upper Guy Sandy. Three areas of Lake of the Arbuckles are closed to all vessels to protect swimmers — the Goddard Youth Camp Cove, an area surrounding The Point, and certain areas near Buckhorn. This exclusion rule is sometimes violated in the Buckhorn and The Point when visitors on PWC visitors and boaters access picnic sites.

Chickasaw has designated no-wake zones. These locations include any area where "No Wake" buoys are located (which include Upper Guy Sandy, Rock Creek, Buckhorn and Dry Branch lake arms) and within 150 feet of all docks, launch ramps, boats at anchor, boats from which people fish, and shoreline areas near campgrounds. No-wake areas are set aside for recreational opportunities that are enhanced by the no-wake environment. Violations of the no-wake zone occur throughout Lake of the Arbuckles.

Visitor Safety

Conflicts in visitor use can arise in areas that restrict boats of any kind, such as the end of Highway 110 and along the Buckhorn Pavilion to the F Loop picnic areas along the lake. These areas attract swimmers who may or may not be associated with a boat or personal watercraft, and the conflict occurs when these vessels come into the areas to beach, pick up passengers, or change operators.

From 1995 to 2000 there were 20 vessel accidents in the recreation area, eight of which involved personal watercraft. Four of the PWC accidents were collisions with boats, two were collisions with other personal watercraft, and two involved PWC operators falling or being thrown off their vessels. Six of the eight accidents resulted in personal injury, and two only in property damage. The accidents occurred in the following areas: Buckhorn Arm (4), Guy Sandy Arm (2), Point Arm (1), and the central lake area (1). From 2001 to present, a total of seven accidents have been reported, five boat-only accidents and two PWC-only accidents.

OBJECTIVES IN TAKING ACTION

Objectives define what must be achieved for an action to be considered a success. Alternatives selected for detailed analysis must meet all objectives and must also resolve purpose of and need for action.

Using the park's enabling legislation, mandates and direction in the *General Management Plan* and the *Resource Management Plan,* issues, and servicewide objectives, park staff identified the following management objectives relative to PWC use:

WATER QUALITY

- Manage PWC emissions that enter the water in accordance with NPS anti-degradation policies and goals.
- Protect plankton and other aquatic organisms from PWC emissions and sediment disturbances so that the viability of dependent species is conserved.
- Manage PWC emissions so that potable water supplies are not impacted.

AIR QUALITY

- Manage PWC activity so that air emissions of harmful compounds do not appreciably degrade ambient air quality.

SOUNDSCAPES

- Manage noise from PWC use so that visitors' health, safety, and experiences are not adversely affected.
- By September 2005, 95% percent of visitors are satisfied with the appropriate facilities, services, and recreational opportunities.

WILDLIFE AND WILDLIFE HABITAT

- Protect birds, waterfowl, and other wildlife from the effects of PWC noise.
- Protect fish and wildlife and their habitats from PWC disturbances.
- Protect fish and wildlife from the adverse effects that result from the bioaccumulation of contaminants emitted from personal watercraft.

THREATENED, ENDANGERED, AND SPECIAL CONCERN SPECIES

- Protect threatened and endangered species, and species of special concern, and their habitats from PWC disturbances.

SHORELINE VEGETATION

- Manage PWC use to protect sensitive shoreline areas from visitor impacts related to such use.
- Manage PWC use to protect sensitive shoreline areas from any potential erosion caused by PWC activity.

VISITOR EXPERIENCE

- Minimize potential conflicts between PWC use and park visitors.
- Manage PWC use consistent with enabling legislation, and provide an appropriately wide range of recreational activities.
- By September 2005, 95% percent of visitors are satisfied with the appropriate facilities, services, and recreational opportunities.

VISITOR CONFLICTS AND VISITOR SAFETY

- Minimize or reduce the potential for PWC user accidents.
- Minimize or reduce the potential safety conflicts between PWC users and other water recreationists.
- Provide a safe and healthful park environment for park visitors.

CULTURAL RESOURCES

- Manage PWC use and access to protect cultural resources, including sacred sites important to Native Americans.
- Manage PWC use and access to protect cultural resources both known and unknown, including Native American sacred sites.

SOCIOECONOMICS

- Work cooperatively with concessioners and local businesses that rent or sell personal watercraft.

NATIONAL RECREATION AREA MANAGEMENT AND OPERATIONS

- Provide a safe and healthful park environment for park visitors.
- Seek cooperation with state entities that regulate PWC use.

ISSUES AND IMPACT TOPICS

Issues associated with PWC use at the park were identified during scoping meetings with NPS staff and as a result of public comments. Many of these issues were identified in the settlement agreement with the Bluewater Network, which requires that at a minimum the effects of PWC use be analyzed for the following: water quality, air quality, soundscapes, wildlife and wildlife habitat, shoreline vegetation, visitor conflicts and visitor safety. Potential impacts to other resources were considered as well. The following impact topics are discussed in the "Affected Environment" chapter and analyzed in the "Environmental Consequences" chapter. If no impacts are expected, based on available information, then the issue was eliminated from further discussion, as explained in the "Issues Eliminated from Further Consideration" section.

WATER QUALITY

The vast majority of personal watercraft in use today are powered by conventional two-stroke, carbureted engines, which discharge as much as 30% of their fuel unburned directly into the water (NPS 1999; CARB 1999). Hydrocarbons, including benzene, toluene, ethyl benzene, and xylene (BTEX) and polyaromatic hydrocarbons (PAHs), are released. These discharges have potential adverse effects on water quality.

Some research shows that PAHs, including those from PWC emissions, adversely affect water quality by means of harmful phototoxic effects on ecologically sensitive plankton and other small water organisms (US EPA 1998; Oris et al. 1998; Landrum et al. 1987; Mekenyan et al. 1994; Arfsten et al. 1996). This in turn can affect aquatic life and ultimately aquatic food chains. The primary concern is in shallow water ecosystems.

Lake of the Arbuckles, located completely within Chickasaw National Recreation Area, serves as a potable water supply for the cities of Ardmore, Davis, and Wynnewood, as well as the Wynnewood Refining Company, through water allocations from the Arbuckle Master Conservancy District. Additionally, the city of Dougherty and the Goddard Youth Camp contract with the Water Conservancy District for potable water. PWC emissions may cause impacts on water quality and subsequent concerns from entities using Lake of the Arbuckles as a potable water supply (Arbuckle Master Conservancy District).

AIR QUALITY

Pollutant emissions such as nitrogen oxides and volatile organic compounds from PWC use may adversely affect air quality. PWC emissions could have some localized impacts, particularly if PWC use increased. New technology and implementation of the EPA 2006 emission requirements are designed to reduce some air quality impacts.

SOUNDSCAPES

PWC-generated noise varies from vessel to vessel. No literature was found that definitively described scientific measurements of personal watercraft noise. Some literature states that all recently manufactured watercraft emit fewer than 80 dB at 50 feet from the vessel, while other sources attributed levels as high as 102 dB without specifying distance. None of this literature fully describes the method used to collect noise data.

The National Park Service contracted for noise measurements of personal watercraft and other motorized vessels in 2001 at Glen Canyon National Recreation Area (Harris Miller Miller & Hanson, Inc., 2002). The results show that maximum PWC noise levels at 82 feet (25 meters) ranged between 68 to 76 dBA. Noise levels for other motorboat types measured during that study ranged from 65 to 86 dBA at 82 feet.

Noise limits established by the National Park Service are 82 dB at 82 feet. Visitors 100 feet away from a PWC user may be exposed to approximately 75 dB, which may be more disturbing due to rapid changes in acceleration and direction of noise from a constant source at 90 dB (US EPA 1974).

WILDLIFE AND WILDLIFE HABITAT

Some research suggests that PWC use impacts wildlife by interrupting normal activities, causing alarm or flight, causing animals to avoid habitat, displacing habitat, and affecting reproductive success. This is thought to be caused by a combination of PWC speed, noise and ability to access sensitive areas, especially in shallow-water depths. Literature suggests that PWC users can access sensitive shorelines, disrupting riparian habitat areas critical to wildlife.

Some research suggests that personal watercraft have a greater impact on waterfowl and nesting birds because of their noise, speed, and ability to access shallow-water areas more readily than other types of watercraft. This may force nesting birds to abandon eggs during crucial embryo development stages and flush other waterfowl from habitat, causing stress and associated behavior changes. Collisions with waterfowl and wildlife may also be of concern.

Malignant neoplasms (cancerous lesions) are present on at least one species of fish in Lake of the Arbuckles (gizzard shad, *Dorosoma cepedianum*). Studies indicate carcinogens or viral origins for non-hepatic (non-liver) neoplasms in fish species.

THREATENED, ENDANGERED, AND SPECIAL CONCERN SPECIES

In some areas PWC use is believed to cause harm to threatened or endangered species because the machine's engine, submerged under the water, muffles the 'warning' sounds that some species depend on to escape from imminent danger. Also, PWC users can access backwater or shallower areas that boats cannot enter. Threatened or endangered species at Chickasaw include the bald eagle, least tern, and whooping crane. These species occur primarily in the park during the winter months, when PWC use is infrequent and the potential for effect low.

Plant species of special concern at Chickasaw, which are listed in the Oklahoma Natural Heritage Inventory, include pincushion cactus (*Corypantha vivipara*), lace cactus (*Echinocereus reichenbachii*), woodland sedge (*Carex cephalophora*), whitesheath hedge (*Carex hyaline*), black dalea (*Dalea frutescens*), scurfpea (*Psoralea reverchonii*), shortlobe oak (*Quercus durandii* var. *breviloba*), grass (*Sporobolus ozarkanus*), and Oklahoma penstemon (*Penstemon oklahomensis*).

SHORELINE VEGETATION

PWC users are able to access areas where most other motorcraft cannot go, which may disturb sensitive plant species. In addition, PWC users may land on the shoreline, allowing them to access areas where sensitive vegetation and plant species exist.

Some research shows that personal watercraft create a wake at slower speeds than most larger boats, and when driven close to shore their wakes can lead to erosion and ultimately shoal formation (Vlasich 1998).

VISITOR EXPERIENCE

Some research suggests that personal watercraft are viewed by some segments of the public as a nuisance due to their noise, speed, and overall environmental effects. However, others believe that personal watercraft are no different from other motorcraft and that users have a right to enjoy the sport.

Chickasaw National Recreation Area is legislatively charged with providing "for public outdoor recreation use and enjoyment of Arbuckle Reservoir and land adjacent thereto." PWC management may affect the enhancement of recreational opportunities or cause changes in the methods and types of recreational activities occurring within the park.

VISITOR CONFLICTS AND VISITOR SAFETY

In 1996 personal watercraft made up 7.5% of the state-registered recreational boats in the United States, but accounted for 36% of recreational boating accidents (NTSB 1998; CARB 1999). In part, this is believed to be a boater education issue, i.e., inexperienced riders lose control of the craft; yet it also is a function of the PWC operation (i.e., no brakes or clutch). When drivers let up on the throttle to avoid a collision, steering becomes difficult. From 1995 to August 2002 there were 27 accidents at Chickasaw involving various types of watercraft, 12 of which (44%) involved personal watercraft.

Personal watercraft, due to their ability to reach high speeds and their ability to access shallow-draft areas can create wakes that pose a conflict and safety hazard to other users, such as canoeists and kayakers.

CULTURAL RESOURCES

Chickasaw has cultural resources listed on, or potentially eligible for listing on, the National Register of Historic Places near Lake of the Arbuckles. These known sites may indicate the presence of other, unknown sites along the shores of the lake. Shoreline erosion and uncontrolled visitor access may affect these resources since riders are able to access / beach / launch in areas less accessible to most motorcraft. Archeological sites may exist on the shoreline and under water; if so, they are all buried. Erosion could cause problems with sites protected under the Native American Graves Protection and Repatriation Act.

Native American resources or use areas may be affected by erosion along shorelines, or by uncontrolled visitor access since riders are able to access / beach / launch in areas less accessible to most motorcraft.

SOCIOECONOMIC ENVIRONMENT

National PWC ownership increased every year between 1991 and 1998; the rate of annual increase peaked in 1994 at 32% and dropped slightly in 1999, 2000, and 2001 (see Table 1). Nine miles from the unit is a business that sells and works on boats. In Ardmore, 15–30 miles away, is a business that sells personal watercraft. There are businesses in other areas 30–60 miles away that sell personal watercraft.

NATIONAL RECREATION AREA MANAGEMENT AND OPERATIONS

Conflict with State and Local Ordinances and Policies Regarding PWC Use

Some states and local governments have taken action, or are considering taking action, to limit, ban, or otherwise manage PWC use. While the park may be exempt from these local actions, consistency with state and local plans must be evaluated.

Impact to Park Operations from Increased Enforcement Needs

PWC use may require additional park staff to enforce standards, limits, or closures because of increased accident rates and visitor conflicts.

ISSUES ELIMINATED FROM FURTHER CONSIDERATION

Historic Structures/Buildings — The only historic structures that have been documented within the national recreation area are located within the Platt District, which is not near Lake of the Arbuckles and will not be specifically affected by PWC use.

Museum Collections — Although Chickasaw maintains a museum collection, these materials are housed in a protective environment and are not specifically affected by PWC use.

Cultural Landscapes — The Platt District comprises a historic designed landscape. It is not located near Lake of the Arbuckles; therefore, this resource type will not be specifically affected by PWC use.

Wetlands — Any potential impacts to wetlands in the vicinity of the shoreline are evaluated under the topic "Shorelines and Shoreline Vegetation." (The extent of the area of impact is defined in the methodology section for shoreline vegetation.) Wetlands that occur farther inland would not be affected by PWC use because of the limited distance that PWC users generally walk when not using their machines.

Floodplains — The level of PWC use and associated PWC activities identified in each alternative would have no adverse impacts on floodplains. No development is proposed in the alternatives; thus, no flooding would result as a result of PWC use and cause impacts to human safety, health, or welfare.

Prime and Unique Agricultural Lands — No prime and unique agricultural farmland exists in the vicinity of areas that would be affected by PWC use.

Energy Requirements and Natural or Depletable Resource Requirements — PWC operation requires the use of fossil fuels. While PWC use could be limited or banned within this park unit, no alternative considered in this environmental assessment would affect the number of personal watercraft used within the region or the amount of fuel that is consumed. The level of PWC use considered in this environmental assessment is minimal. Fuel is not now in short supply, and PWC use would not have an adverse effect on continued fuel availability.

Impacts to Economically Disadvantaged or Minority Populations (Executive Order 12898) — Local residents may include low-income populations. However, these populations would not be particularly or disproportionately affected by continuing or discontinuing PWC use. Other areas near the park are available to all PWC users. There are no small business owners in the Chickasaw area that rent personal watercraft as a primary source of income. Park actions would not disproportionately affect minority or low-income populations. This issue was dismissed from further analysis for the following reasons:

1. Personal watercraft are used by a cross section of ethnic groups and income levels.
2. Other areas are available and open to personal watercraft and are used by all ethnic groups and income levels.
3. NPS actions would not disproportionately affect minority or low-income populations.

4. Any NPS actions to limit PWC use would not displace PWC use to low-income or ethnically sensitive areas.

RELATIONSHIP TO OTHER PLANS, POLICIES, AND ACTIONS

The following plans, policies, and actions could affect the alternatives being considered for PWC use at Chickasaw. These plans and policies are also considered in the analyses of cumulative effects.

PARK POLICIES, PLANS, AND ACTIONS

Other plans, policies, and actions at the federal, state, and local level that may affect decisions for PWC use were discussed with the NPS staff, along with existing and future plans and policies at Chickasaw. A list of plans, policies, and other actions that may be relevant to PWC use or cumulative impacts analysis follows:

- *General Management Plan* (July 1979).
- *General Management Plan Addendum with Development Concept Plan and Environmental Assessment, Veterans Lake, Chickasaw National Recreation Area, Murray County, OK,* April 1985 with "Finding of No Significant Impact" (March 14, 1985).
- *Final Amendment to General Management Plan / Development Concept Plan Environmental Assessment* and "Finding of No Significant Impact" (October 31, 1994).
- *Resource Management Plan for Chickasaw National Recreation Area* (revised September 1988).
- *Water Resources Management Plan, Chickasaw National Recreation Area, OK* (July 31, 1998).
- The National Park Service and the Chickasaw Nation have proposed to develop a cultural center at Chickasaw National Recreation Area and the access road to The Point.
- The National Park Service has proposed the development of a new visitor center in 2003.
- Chickasaw plans to begin developing a new general management plan in 2002.

LOCAL OR STATE POLICIES, PLANS, OR ACTIONS

- The Chickasaw Nation has proposed a new development, including a casino, lodge, and convention facility, in Davis, Oklahoma.
- A private interest has proposed the sale of water in the Arbuckle Simpson aquifer to communities in Canadian County. The proposed project could affect water quantity and quality in Lake of the Arbuckles, because the aquifer feeds into the lake.

ALTERNATIVES

All alternatives must be consistent with the purpose and significance of the Chickasaw National Recreation Area, and they must meet the purpose of and need for action, as well as the objectives for the project. Four alternatives are described in this section.

The alternatives, which are analyzed in accordance with the National Environmental Policy Act, are the result of agency and public scoping input. The action alternatives address continued PWC use under a special regulation; two alternatives include new management strategies and mitigation measures. The no-action alternative would not allow PWC use. Table 3 at the end of this chapter summarizes the alternatives being considered, and Table 4 summarizes the impacts of each alternative. Table 5 lists issues associated with PWC use, management objectives for addressing the issues, and an analysis of how each alternative meets the objectives.

ALTERNATIVE A — CONTINUE PWC USE UNDER A SPECIAL REGULATION

Alternative A would continue PWC use on the lake as it has been permitted under the "Superintendent's Compendium" (see appendix A) and applicable state regulations. The following summarizes the provisions of alternative A; specific locations mentioned in the text are shown on the map for this alternative.

Areas of Use / Location Restrictions. PWC use would continue in all locations of the recreation area where it is allowed under the current "Superintendent's Compendium." This includes all parts of Lake of the Arbuckles, but not any other lakes in the park.

Wake Restrictions. Personal watercraft (as well as other vessels) would continue to be limited to speeds no greater than 5 mph on Lake of the Arbuckles within the confines of all no-wake zones. These are defined as those areas within 150 feet of all persons, docks, launch ramps, buoys, boats at anchor, boats from which people are fishing, shoreline areas near campgrounds, or any other prohibitive structure. The areas that have "No Wake" buoys on the lake include the confines of Guy Sandy Harbor and Buckhorn Harbor as defined by the breakwaters and within the Rock Creek arm.

Launch Restrictions. Launch areas would remain at the Buckhorn, The Point, Guy Sandy, and Upper Guy Sandy (state boat ramp) launch ramps.

Safety/Operating Restrictions. The following Oklahoma State regulations would continue to be enforced:

- Children younger than 12 are not allowed to operate personal watercraft by themselves in park waters.
- Personal watercraft cannot be operated at a speed that exceeds the established speed limits.
- Personal watercraft may not be operated within 50 feet of another vessel while traveling at 10 mph or faster.
- Use of a cutoff, if installed by the manufacturer, is required.
- Towing a water-skier is prohibited unless a cutoff switch is installed.
- Personal watercraft must have an observer in addition to the operator, or wide-angle mirrors for use by operator to see the person being towed.

- Personal watercraft are not allowed to operate from sunset to sunrise.
- Personal flotation devices (PFD) are mandatory for all PWC riders.
- PWC users cannot operate in a reckless or negligent manner that endangers life or property.
- Operating a vessel under the influence of drugs or alcohol is prohibited.

Rental Restrictions. Incidental business permits are required for vendors who rent personal watercraft.

Consultations. Affiliated Native American Tribes would be consulted on the protection of sites within the recreation area.

ALTERNATIVE B — CONTINUE PWC USE UNDER A SPECIAL REGULATION WITH ADDITIONAL MANAGEMENT RESTRICTIONS (PREFERRED ALTERNATIVE)

The following provisions would remain the same as those listed above for alternative A: launch restrictions, safety/operating restrictions (speed, time, PFD requirements, cutoff switch), and rental restrictions. Under alternative B the following additional management restrictions would be put into effect:

Areas of Use / Location Restrictions. The following locational restrictions would be applied:

- Monitor for the presence of threatened or endangered species, and seasonally or permanently close sites as needed to protect such species.
- Monitor for cultural sites, and seasonally or permanently close sites as needed for resource protection.

Equipment and Emissions Restrictions. PWC operators would be required to have state boater registration cards or information on the model year and emissions for their watercraft prior to being allowed to recreate on Lake of the Arbuckles. The fueling of personal watercraft would be prohibited on the water surface or where there is no positive protection between water surface and the shoreline fueling operation. This means that fueling would be allowed only while the personal watercraft is trailered and/or away from the water surface.

Wake Restrictions. The no-wake zones under alternative A would continue, but the following no-wake zone would be extended:

- Extend the no-wake zone around the Buckhorn developed area from the existing launch ramp cove to the Buckhorn C Loop Cove in a 150-foot buffer along the shoreline, with PWC use allowed subject to additional restrictions in the presence of swimmers.

Number Restrictions. Monitor PWC numbers to determine establishment of a carrying capacity when and if impacts to air and water quality exceed a minor to moderate adverse effect.

Safety/Operating Restrictions. The current state regulatory restrictions as described in alternative A would be continued, with the following changes:

- 12-year-old operators must be accompanied by an adult.

Enforcement. The enforcement of new restrictions would be enhanced. A voluntary, self-regulatory PWC user group would be established at Chickasaw to develop its own club rules and guidelines and to provide education for PWC users, although the rules would not have the force of federal or state laws.

Monitoring and Sampling. A baseline for resource conditions would be established, and a monitoring program would be established to measure resource changes and impacts as a result of PWC use. Resources to be monitored would include, but would not be limited to, water quality, shoreline erosion, and visitor use patterns. (Monitoring requirements would be based on issues and potential for negative impacts disclosed in the PWC environmental assessment analysis.)

Fees. User fees would be increased to cover higher monitoring and enforcement costs of new restrictions, as well as potential costs for resource management (restoration to shoreline vegetation and cultural resources and to cover the educational program). User fee refunds and rate reductions would be offered for users who voluntarily complied with the EPA 2006 emission standards. Increase the user fee to cover the cost of the educational program.

Consultations. In addition to consulting with affiliated Native American tribes on the protection of sites within the recreation area, measures would be developed in consultation with affected local businesses to mitigate any potential effects of PWC regulation and use changes.

Education. A voluntary user education program would be established, including brochures, maps, and interpretive talks.

ALTERNATIVE C — CONTINUE PWC USE UNDER A SPECIAL REGULATION BUT LIMIT AREAS OF USE AND IMPLEMENT OTHER RESTRICTIONS

PWC use would continue to be allowed, but the area of use would be limited and additional use restrictions would be enforced. The following provisions would remain the same as or similar to those required under alternative B: enforcement, monitoring and sampling provisions, rental restrictions, and consultations with affiliated Native American tribes and local businesses. The additional area and operating restrictions under alternative C are listed below.

Areas of Use / Location Restrictions. The following locational restrictions would be applied:

- Restrict PWC use to the body and some arms of Lake of the Arbuckles, as shown on the map of this alternative.
- Limit PWC use within 150 feet of all shorelines except for certain access areas, such as launch ramps and designated mooring areas.
- Prohibit PWC use in the following areas:

  the no-wake zone in the Guy Sandy arm as currently defined

  the no-wake zone in the Rock Creek arm, but extended to just north of The Point campground
- Monitor for the presence of threatened or endangered species, and seasonally or permanently close sites as needed to protect such species (same as alternative B).
- Monitor for cultural sites, and seasonally or permanently close sites as needed for resource protection (same as alternative B).

Equipment and Emissions Restrictions. By April 15, 2005, all personal watercraft would have to meet the U.S. Environmental Protection Agency's 2006 manufacturing emission standards of a 75% reduction in hydrocarbon emissions. In addition, PWC operators would be required to have state boater registration cards or information on the model year and emissions for their watercraft prior to being allowed to recreate on Lake of the Arbuckles. The fueling of personal watercraft would be prohibited on the water surface or where there is no positive protection between the water surface and the shoreline fueling

operation. This means that fueling would be allowed only while the personal watercraft was trailered and/or away from the water surface.

Wake Restrictions. The no-wake zones under alternatives A and B would continue, but the following no-wake zones would be extended:

- Combine and extend the Buckhorn arm no-wake zone to a line drawn between Goddard Youth Camp Cove and the Buckhorn campground A and B loop cove.

Number Restrictions. A PWC carrying capacity would be established by limiting PWC permits to day use only, eliminating annual permits, and setting a maximum number of permits per day.

Launch Restrictions. PWC users would no longer be allowed to launch at Upper Guy Sandy.

Safety/Operating Restrictions. The current state regulatory restrictions as described in alternative A would be continued, with the following changes:

- Raise age requirement for PWC operators to 16 (or older) with possession of a valid drivers license.
- Either change hours of operation to 9 A.M. to 5 P.M., or limit PWC use to less than seven-days a week (e.g., only weekend or holiday operation).

Fees. User fees would be increased to cover the cost of the educational program. User fee refunds or rate reductions would be offered to PWC users voluntarily complying with the 2006 EPA emission standards before April 15, 2005.

Education. A mandatory user education program would be established, with Chickasaw providing brochures, maps, interpretive talks, etc., as part of the educational program.

NO-ACTION ALTERNATIVE — NO PWC USE

The no-action alternative would discontinue PWC use, and the National Park Service would take no action to draft a special regulation to continue PWC use.

THE ENVIRONMENTALLY PREFERRED ALTERNATIVE

The environmentally preferred alternative is defined by the Council on Environmental Quality as the alternative that best meets the following criteria or objectives, as set out in section 101 of the National Environmental Policy Act:

- Fulfill the responsibilities of each generation as trustee of the environment for succeeding generations.
- Ensure for all Americans safe, healthful, productive, and aesthetically and culturally pleasing surroundings.
- Attain the widest range of beneficial uses of the environment without degradation, risk of health or safety, or other undesirable and unintended consequences.
- Preserve important historic, cultural, and natural aspects of our national heritage and maintain, whenever possible, an environment that supports diversity and variety of individual choice.

- Achieve a balance between population and resource use that will permit high standards of living and a wide sharing of life's amenities.
- Enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources.

This discussion also summarizes the extent to which each alternative meets section 102(1) of the National Environmental Policy Act, which asks that agencies administer their own plans, regulations, and laws so that they are consistent with the policies outlined above to the fullest extent possible.

Alternative A would satisfy the majority of the six requirements detailed above; however, alternative A would not ensure safe, healthful, productive, and aesthetically pleasing surroundings because PWC use would be allowed in areas frequented by passive outdoor recreationists. Alternative A would not attain the widest range of beneficial uses of the environment without degradation, risk of health or safety, or other undesirable and unintended consequences because of the potential impacts of PWC use on visitor experiences. For this reason, alternative A is not preferred from an environmental perspective.

Alternative B would have impacts on park resources and visitor use and experience at Chickasaw similar to those described for alternative A; however, it would increase the no-wake zone around the Buckhorn developed area. Alternative B would allow limited access to the lake in designated areas, enabling PWC users to enjoy a wide range of beneficial uses of park amenities while maintaining an environment that supports diversity and variety of individual choice. Alternative B would attain a wide range of beneficial uses of the environment, but the potential would still exist for degradation and risk to visitor health and safety, specifically as it relates to water and air quality. Alternative B is the park's preferred alternative for managing PWC use.

Alternative C would have impacts on the national recreation area's natural resources similar to those under alternatives A and B. However, alternative C would better meet park goals with respect to the protection of visitor experience, wildlife and wildlife habitat, shoreline vegetation, and cultural resource protection by prohibiting PWC use within the three exclusion areas. In the long term, this alternative would help visitors enjoy a beneficial use by allowing access to national recreation area amenities by personal watercraft while accommodating passive outdoor recreationists and meeting resource management objectives. This alternative would accommodate recreational opportunities for visitors while protecting sensitive natural and cultural resources. Alternative C is designed to meet the National Park Service's general prohibition on PWC use for the protection of park resources and values, while providing access to the national recreation area by PWC operators.

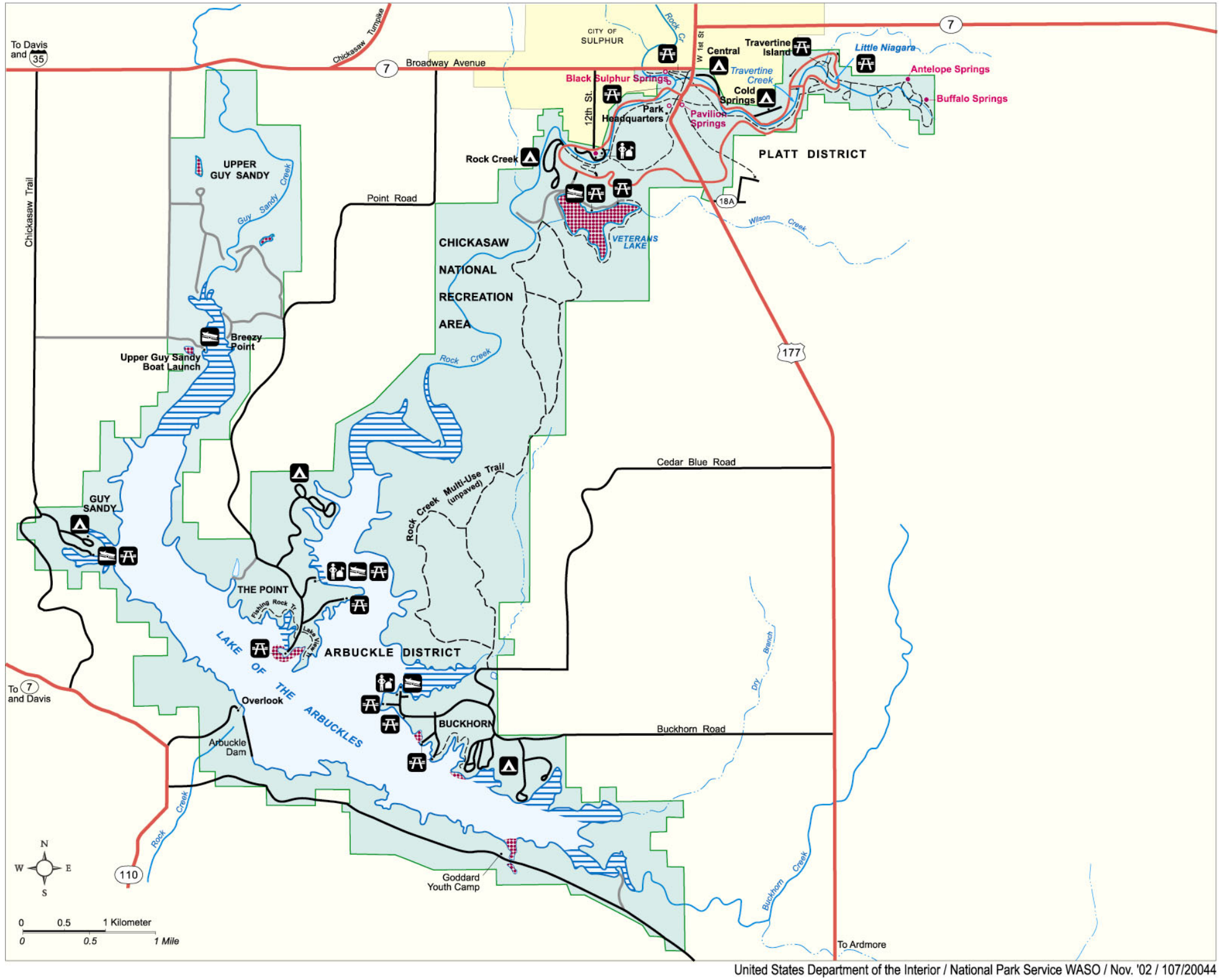
The no-action alternative would ensure a safe, healthful, productive, and aesthetically and culturally pleasing area for visitors to access without the threat of PWC users introducing noise and safety concerns. The no-action alternative would attain the widest range of beneficial uses of the environment without degradation, risk of health or safety, or other undesirable and unintended consequences by removing PWC use from the national recreation area entirely. However, the no-action alternative would not maintain an environment that supports diversity and variety of individual choice, nor would it achieve a balance between population and resource use that permits a wide sharing of amenities.

Based on the analysis prepared for PWC use at Chickasaw, alternative C is considered the environmentally preferred alternative by best fulfilling park responsibilities as trustee of sensitive habitat; by ensuring safe, healthful, productive, and aesthetically and culturally pleasing surroundings; and by attaining a wider range of beneficial uses of the environment without degradation, risk of health or safety, or other undesirable and unintended consequences.

Chickasaw National Recreation Area

Oklahoma

Alternative A -- Continue PWC Use under a Special Regulation



United States Department of the Interior / National Park Service WASO / Nov. '02 / 107/20044

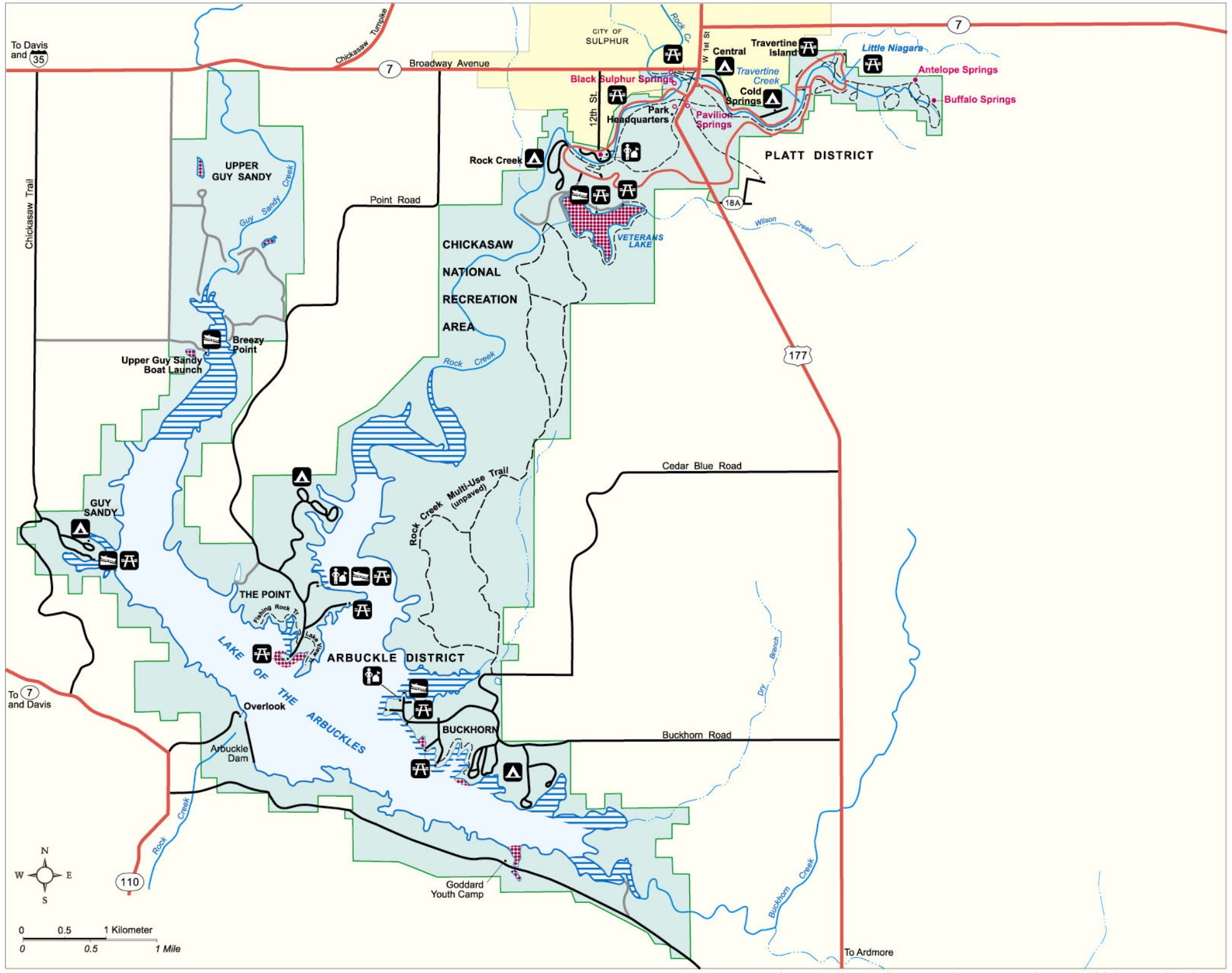
- Campground
- Ranger station
- Boat ramp
- Picnic area
- Open water
- Controlled area (no wake)
- PWC exclusion area
- Hiking Trail
- Fresh water spring
- Mineral water spring

Blank – back of map

Chickasaw National Recreation Area

Oklahoma

Alternative B -- Continue PWC Use under a Special Regulation with Additional Management Restrictions*



United States Department of the Interior / National Park Service WASO / Nov. '02 / 107/20045

Campground
Boat ramp
Open water
Hiking Trail
Ranger station
Picnic area
Controlled area (no wake)
Fresh water spring
PWC exclusion area
Mineral water spring

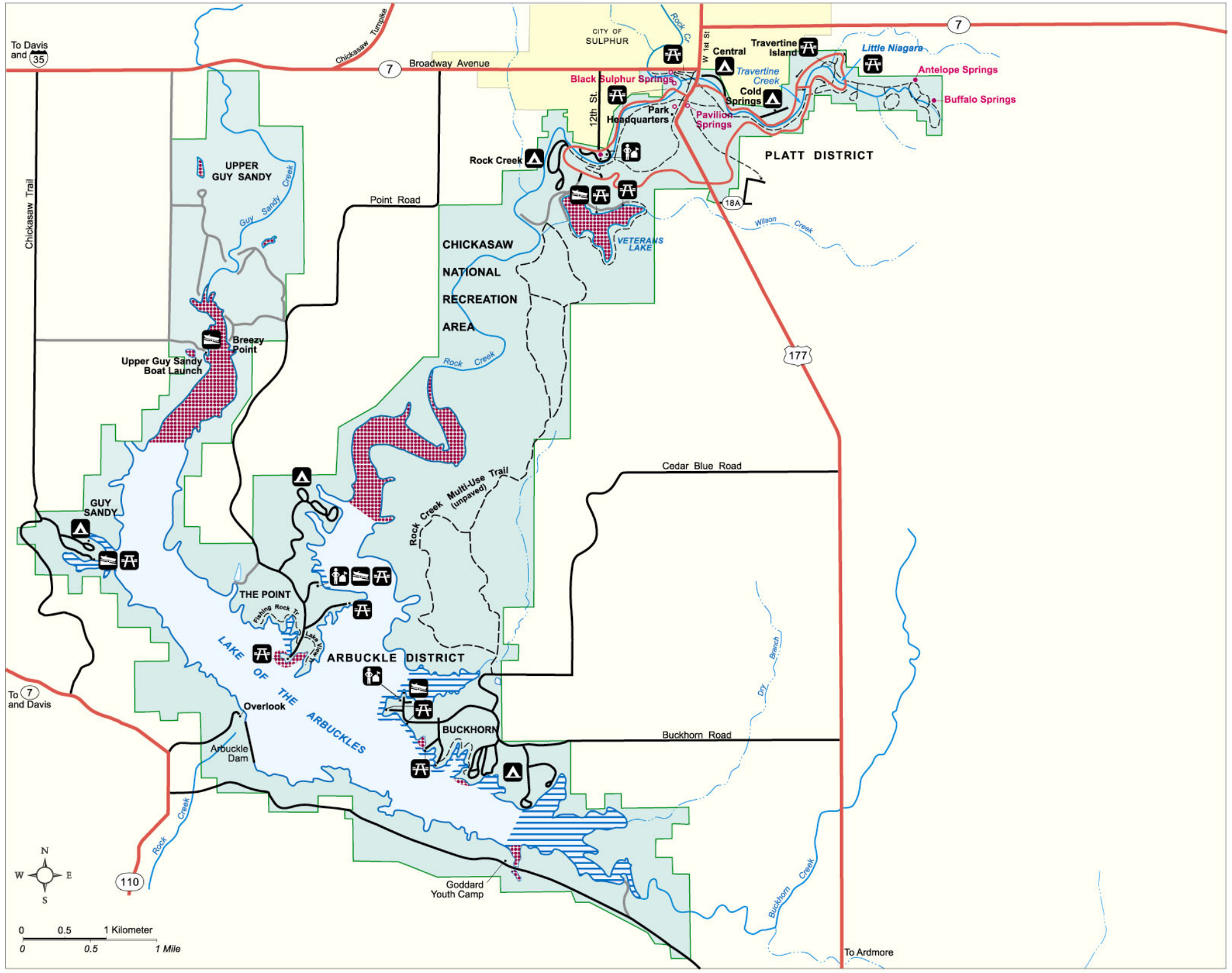
* Physical management zones under alternative B would be the same as under alternative A. Please see additional management restrictions in the alternatives matrix.

Blank – back of map

Chickasaw National Recreation Area

Oklahoma

Alternative C -- Continue PWC Use under a Special Regulation but Limit Areas of Use and Implement Other Restrictions*



United States Department of the Interior / National Park Service WASO / Nov. '02 / 107/20046

Campground

Boat ramp

Ranger station

Picnic area

Open water

Controlled area (no wake)

PWC exclusion area

Hiking Trail

Fresh water spring

Mineral water spring

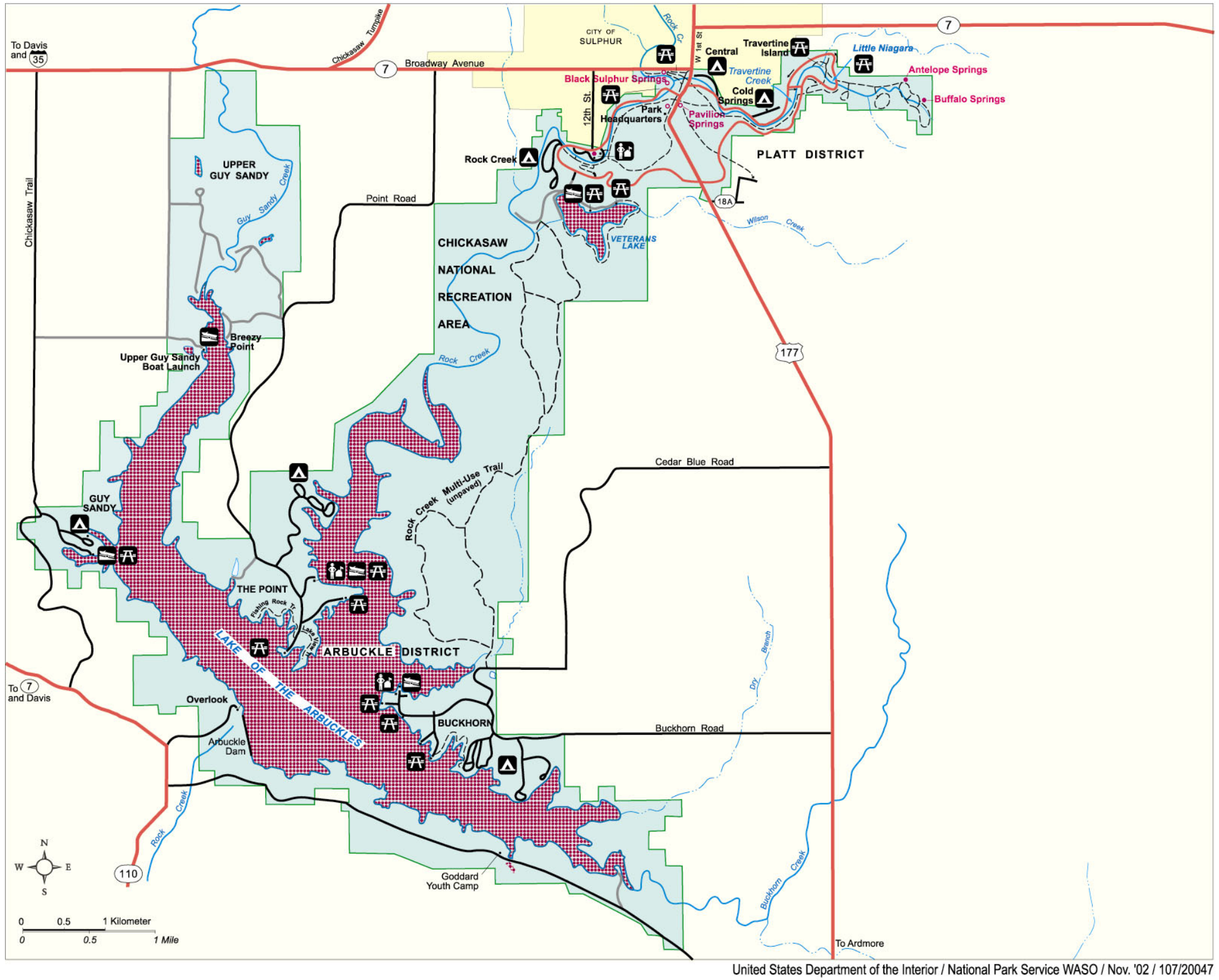
* Please see additional management restrictions in the alternatives matrix.

Blank – back of map

Chickasaw National Recreation Area

Oklahoma

No-Action Alternative --
No PWC Use



United States Department of the Interior / National Park Service WASO / Nov. '02 / 107/20047

Campground
Boat ramp
PWC use prohibited
Hiking Trail
Ranger station
Picnic area
Fresh water spring
Mineral water spring

Blank – back of map

TABLE 3: SUMMARY OF ALTERNATIVES

Elements	Alternative A — Continue PWC Use under a Special Regulation	Alternative B — Continue PWC Use under a Special Regulation with Additional Management Prescriptions	Alternative C — Continue PWC Use but Limit Area of Use and Implement Other Restrictions	No-Action Alternative — No PWC Use
Areas of Use	Continue PWC use in locations where currently allowed.	Continue PWC use in locations where currently allowed.	Continue PWC use, but restrict use to the main body and some arms of Lake of the Arbuckles.	Prohibit PWC use within the national recreation area.
Location Restrictions	No PWC operation in lakes of 100 acres or less (i.e., PWC use permitted only on Lake of the Arbuckles).	Same as alternative A.	Same as alternative A.	No PWC use.
			Limit PWC use to 150′ from shorelines except for certain access areas (launch ramps, designated mooring areas.)	
			Allow no PWC use in the following no-wake zones: • the Guy Sandy arm no-wake zone as currently defined • the Rock Creek arm no-wake zone extended to just north of The Point campground.	
		Monitor for the presence of threatened or endangered species; seasonally or permanently close sites as needed to protect such species.	Same as alternative B.	
		Monitor for cultural sites and seasonally or permanently close sites as needed for resource protection.	Same as alternative B.	
Equipment and Emissions Restrictions	Not applicable.		By April 15, 2005, require all PWC users to meet the 2006 EPA marine emission standards.	No PWC use.
			Restrict PWC use to four-stroke engines or two-stroke direct-injected engines that meet the same emission standards.	
		Require state boat registration card or information on PWC model year and emissions prior to permitting operation on Lake of the Arbuckles.	Same as alternative B	
		Prohibit PWC fueling where there is no positive protection between water surface and fueling operation on shoreline or from water surface (fueling only allowed while craft was trailered, away from water surface).	Same as alternative B.	
Wake Restrictions	Maintain a speed limit of 5 mph within no-wake zones, defined as those areas within 150′ of all persons, docks, launch ramps, buoys, boats at anchor, boats from which people are fishing, shoreline areas near campgrounds, or any other prohibitive structure.	Same as alternative A plus:	Same as alternative A plus:	No PWC use.

Elements	Alternative A — Continue PWC Use under a Special Regulation	Alternative B — Continue PWC Use under a Special Regulation with Additional Management Prescriptions	Alternative C — Continue PWC Use but Limit Area of Use and Implement Other Restrictions	No-Action Alternative — No PWC Use
		Extend no-wake zone around the Buckhorn developed area from the existing launch ramp cove to the Buckhorn C Loop Cove in a 150′ buffer along the shoreline, with PWC use allowed subject to additional restrictions in the presence of swimmers.	Same as alternative B.	
			Combine and extend the Buckhorn arm no-wake zone to a line drawn between the Goddard Youth Camp cove and the Buckhorn campground A and B loop cove.	
	Maintain wakeless zones in any location where "No Wake" buoys are present; on Lake of the Arbuckles, including the confines of Guy Sandy Harbor and Buckhorn Harbor as defined by the breakwaters and within the Rock Creek arm.	Same as alternative A.	Same as alternative A.	
Number Restrictions	Not applicable.	Monitor PWC numbers to determine carrying capacity when and if impacts to air and water quality exceed a minor to moderate adverse effect.	Establish a PWC carrying capacity by limiting PWC permits to day-use only and setting a maximum number per day.	
Launch Restrictions	Retain launch areas at Buckhorn, The Point, Guy Sandy and Upper Guy Sandy (state boat ramp).	Same as alternative A.	Same as alternative A except no PWC launching at Upper Guy Sandy.	No PWC launching or retrieval permitted.
Safety/Operating Restrictions				
•Age Restrictions and Certification Requirements	In accordance with Oklahoma State law, do not allow children younger than 12 to operate personal watercraft in park waters.	Same as alternative A plus 12 year olds must be accompanied by an adult.	Raise age requirement for PWC operators to 16 (or older) with possession of a valid drivers license.	Not applicable
•Speed Restrictions	According to state regulations, do not allow personal watercraft to operate at a speed that exceeds the established speed limits. No PWC operation within 50′ of another vessel while traveling at 10 mph or faster.	Same as alternative A.	Same as alternative A.	Not applicable
•Flotation Devices	According to state regulations, require all PWC riders to wear personal flotation devices.	Same as alternative A.	Same as alternative A.	Not applicable.
•Lanyard Cutoff	According to state regulations, require use of a cutoff if installed by the manufacturer. No towing of a water-skier unless a cutoff switch is installed. Require an observer to be present in addition to the operator, or wide-angle mirrors for use by operator to see person being towed.	Same as alternative A.	Same as alternative A.	Not applicable.

Elements	Alternative A — Continue PWC Use under a Special Regulation	Alternative B — Continue PWC Use under a Special Regulation with Additional Management Prescriptions	Alternative C — Continue PWC Use but Limit Area of Use and Implement Other Restrictions	No-Action Alternative — No PWC Use
•Time Restrictions	Allow PWC operation from sunrise to sunset.	Same as alternative A.	Allow PWC operation from 9 A.M. to 5 P.M. or Limit PWC use to less than seven days a week (e.g., PWC use only on weekends or holidays).	No PWC use.
•Operating Restrictions	According to state law PWC users may not operate in a reckless or negligent manner that endangers life or property or operate a vessel under the influence of drugs or alcohol.	Same as alternative A.	Same as alternative A.	Not applicable.
Rental Restrictions	Require incidental business permits for vendors to rent personal watercraft.	Same as alternative A.	Same as alternative A.	Not applicable.
Enforcement	No requirements.	Increase/enhance enforcement of new restrictions.	Same as alternative B.	Focus enforcement on PWC ban.
		Develop/establish self-regulatory PWC user group.	Same as alternative B.	Focus enforcement on PWC ban.
Monitoring and Sampling	No monitoring or sampling.	Develop/expand current baseline and monitor resource changes/impacts, including, but not limited to, water quality, shoreline erosion, and visitor use patterns. Base monitoring requirements on issues or potential for negative impacts disclosed in PWC environmental assessment analysis.	Same as alternative B.	Not applicable.
Fees	None.	Increase user fees to cover increased monitoring and enforcement costs of new restrictions.	Similar to alternative B.	No fees from PWC use.
		Offer user fee refunds/rate reductions for users voluntarily complying with 2006 EPA marine emission standards.	Offer user fee refunds or rate reductions for users voluntarily complying with 2006 EPA marine emission standards prior to April 15, 2005.	No fees from PWC use.
		Increase user fee to cover identified resource damage restoration to shoreline vegetation and cultural resources and to cover educational program	Increase user fee to cover costs of educational program.	Increase other park user fees to cover lost PWC revenue, or reduce services as required.
Consultations	Consult with affiliated Native American tribes on protection of sites within the recreation area	Same as alternative A.	Same as alternative A.	Consult with affiliated Native American tribes on change of park operations.
		Consult with affected local businesses to determine and mitigate potential effects of PWC regulation/use changes.	Same as alternative B.	Same as alternative B.
Education	None.	Establish voluntary user education program, with national recreation area providing brochures, maps, interpretive talks, etc. as part of an education program	Same as alternative B except make program mandatory for PWC users.	Provide information to visitors explaining why PWC use is prohibited.

TABLE 4: SUMMARY OF ENVIRONMENTAL CONSEQUENCES

Impact Topic	Alternative A: Continue PWC Use under a Special NPS Regulation	Alternative B: Continue PWC Use under a Special NPS Regulation with Management Restrictions	Alternative C: Continue PWC Use but Limit Area of Use and Implement Other Restrictions	No-Action Alternative — No PWC Use
Water Quality	Continuing PWC use would have negligible adverse impacts on water quality based on ecotoxicological benchmarks in 2002 and 2012 and on human health benchmarks (benzo(a) pyrene). The impact from benzene, based on human health benchmarks, would be minor in Lake of the Arbuckles (area 1) in both 2002 and 2012; in the no-wake zones (area 2) the impact would be moderate in 2002, decreasing to minor in 2012. On a cumulative basis all pollutant loads in 2002 and 2012 from PWC and other motorboat use based on ecotoxicological benchmarks would be negligible. Based on human health benchmarks, water quality impacts from benzo(a)pyrene would be negligible in 2002 and 2012; but water quality impacts from benzene could be potentially major in 2002 in Lake of the Arbuckles (area 1) and the no-wake zones (area 2). In 2002 it could take up to 10 hours for benzene concentrations to be reduced below the human health benchmark as a result of mixing and dilution. By 2012 impacts from benzene would decrease to moderate in both areas. Impacts from benzene could be greater if a strong thermocline developed, effectively limiting the volume of water available for mixing and dilution. Monitoring of water quality for benzene would be required to confirm the estimates of impacts following a high-use day. Impacts in the no-wake zones could be reduced by the inflow of water from the streams feeding the lake. No impairment expected.	Continuing PWC use with additional management restrictions would have negligible adverse impacts on water quality in 2002 and 2012 based on all ecotoxicological benchmarks and on the human health benchmark for benzo(a) pyrene. PWC impacts to water quality from benzene in Lake of the Arbuckles (area 1) would be minor in 2002 and 2012; impacts in the no-wake zones (area 2) would be potentially moderate in 2002, decreasing to minor in 2012. Cumulative water quality impacts would be negligible in 2002 and 2012 except for benzene under the human health benchmark. Cumulative impacts from benzene could be potentially major in 2002, decreasing to moderate in 2012 in areas 1 and 2 as a result of improved engine technology. Benzene impacts in Lake of the Arbuckles could be greater if a strong thermocline became established. Conversely, impacts in the no-wake zones (area 2) could be reduced by the inflow of water from the streams feeding the lake. Monitoring of water quality for benzene in Lake of the Arbuckles would be required to confirm the estimates of impacts following a high-use day. Impacts would also be reduced by prohibiting refueling operations on the water. No impairment expected.	Water quality impacts from PWC use in 2002 and 2012 would be negligible for all ecotoxicological benchmarks and for benzo(a)pyrene under human health benchmarks. Impacts from benzene under human health benchmarks would be moderate in 2002, decreasing to negligible by 2012. Cumulative water quality impacts in 2002 and 2012 would be negligible under all ecotoxicological benchmarks and for benzo(a)pyrene under human health benchmarks in all areas. Impacts from benzene in 2002 under human health benchmarks could be potentially major in Lake of the Arbuckles (area 1) and moderate in the no-wake zones (areas 2) and PWC use prohibited zones (area 3). By 2012 impacts from benzene are expected to decrease to moderate in areas 1 and 3 and to minor in area 2. Impacts from benzene in area 1 could be greater if a strong thermocline developed, thus reducing the volume of water available for mixing and dilution. Monitoring of water quality for benzene in Lake of the Arbuckles could be required to confirm the estimates of impacts following a high-use day. Impacts in the no-wake zones (area 2) could be reduced by the inflow of water from the streams feeding the lake. Impacts would also be reduced by prohibiting refueling operations on the water. No impairment expected.	Discontinuing PWC use would have a beneficial impact on water quality because pollutant loads from personal watercraft would be eliminated. Cumulative impacts from all other motorboats would be negligible under all ecotoxicological benchmarks and for benzo(a)pyrene under the human health benchmarks. Impacts from benzene under the human health criteria in Lake of the Arbuckles could be potentially major in 2002, decreasing to moderate by 2012. In the no-wake zones, impacts would be moderate in 2002, decreasing to minor by 2012. Impacts in Lake of the Arbuckles could be greater if a strong thermocline developed, reducing the volume of water available for mixing and dilution. Monitoring of water quality for benzene in the lake could be required to confirm the estimates of impacts following a high-use day. No impairment expected.
Air Quality				
• Impacts to Human Health from Airborne Pollutants Related to PWC Use	Continuing PWC use would result in a moderate adverse impact from CO, a minor adverse impact from VOC, and negligible adverse impacts from PM_{10} and NO_x in 2002. In 2012 the impact from CO would remain moderate,	Continuing PWC use would result in a moderate adverse impact from CO, a minor adverse impact from VOC, and negligible adverse impacts from PM_{10} and NO_x in 2002. In 2012 the impact level for CO would remain moderate	Continuing PWC use with restrictions would result in a moderate adverse impact from CO, a minor adverse impact from VOC, and negligible adverse impacts from PM_{10} and NO_x in 2002. Emissions would be reduced	Banning PWC use would have beneficial impacts on air quality because of decreased emissions. Compared to alternative A, emissions from all other motorized watercraft would be reduced, with

Impact Topic	Alternative A: Continue PWC Use under a Special NPS Regulation	Alternative B: Continue PWC Use under a Special NPS Regulation with Management Restrictions	Alternative C: Continue PWC Use but Limit Area of Use and Implement Other Restrictions	No-Action Alternative — No PWC Use
	while impacts from VOC, PM_{10}, and NO_x impacts would be negligible. Cumulative emission levels for CO would be moderate adverse in both 2002 and 2012, while VOC emissions would be moderate adverse in 2002, decreasing to minor in 2012. Impacts would be negligible for PM_{10} and NO_x in 2002 and 2012. This alternative would maintain existing air quality conditions, with future reductions in PM_{10}, HC, and VOC emissions due to improved emission controls. No impairment.	adverse, and VOC, PM_{10}, and NO_x impacts would be negligible. Extending the no-wake zone in the area of the Buckhorn developed area would reduce the emissions of all pollutants except NO_x in comparison to alternative A. Cumulative emission levels for CO would be moderate adverse in both 2002 and 2012. Impacts for VOC would decrease from moderate in 2002 to minor in 2012, while impacts for PM_{10} and NO_x would be negligible. This alternative would maintain existing air quality conditions, with future reductions in PM_{10}, HC, and VOC emissions due to improved emission controls. No impairment.	compared to alternative A because no-wake zones would be extended and areas would be closed to PWC use. In 2012 impacts from CO would be minor due to an overall reduction in carbureted two-stroke engines, and impacts from VOC, PM_{10}, and NO_x would be negligible. Cumulative emission levels would result in moderate adverse impacts from CO in both 2002 and 2012; minor adverse impacts from VOC in 2002, decreasing to negligible by 2012; and negligible adverse impacts from PM_{10} and NO_x. This alternative would maintain existing air quality conditions, with future reductions in PM_{10}, HC, and VOC emissions due to anticipated improved emission controls and banning two-stroke carbureted PWC engines in 2005. No impairment.	no contribution from PWC use. Impacts from CO would be moderate in 2002 and 2012, while impacts from PM_{10}, VOC, and NO_x would be negligible throughout the assessment period. With improved emission controls, future emissions of most pollutants would gradually decline, although NO_x emissions would increase slightly. No impairment.
• Impacts to Air Quality Values from Pollutants Related to PWC Use	Continuing PWC use would have negligible adverse impacts on visibility in both 2002 and 2012. There would be a minor adverse impact from ozone exposure in 2002 and 2012. Overall impacts to air quality related values would be minor in 2002 and 2012. On a cumulative basis there would be negligible visibility impacts and minor adverse impacts from ozone exposure in 2002 and 2012. Ambient elevated ozone levels in the Chickasaw area appear to be primarily a result of ozone formation in northern Texas and l transport into southern Oklahoma, and not a result of local conditions. Therefore impact levels from regional sources have been de-emphasized. Overall combined impacts to air quality related values are anticipated to be minor in both 2002 and 2012. No impairment.	Alternative B would have negligible adverse impacts on visibility and a minor adverse impact from ozone exposure in 2002 and 2012. Overall impacts to air quality related values would be minor in both 2002 and 2012. On a cumulative basis impacts on visibility would be negligible and impacts related to ozone exposure would be minor. SUM06 ozone monitoring data indicate that Chickasaw is influenced by the transport of ozone and its precursor pollutants from northern Texas. Overall combined impacts to air quality related values are anticipated to be minor in both 2002 and 2012. No impairment.	Under alternative C impacts related to PWC use would be negligible in 2002 and 2012. There would be a minor adverse impact from ozone exposure in 2002 and 2012 from PWC alone. Overall impacts to air quality related values would be minor in both 2002 and 2012. On a cumulative basis, there would be negligible impact levels to visibility in both 2002 and 2012 and a minor impact from ozone exposure. SUM06 ozone monitoring data indicate that Chickasaw is influenced by the transport of ozone and its precursor pollutants from northern Texas. Overall combined impacts to air quality related values are anticipated to be minor in both 2002 and 2012. No impairment.	Banning PWC use would result in beneficial impacts on air quality related values. On a cumulative basis there would be a negligible impact to visibility and a minor impact from ozone exposure in 2002 and 2012 when all motorized watercraft and other ozone sources are considered. SUM06 ozone monitoring data indicate that Chickasaw is influenced by the long-distance transport of ozone and its precursor pollutants, and that banning PWC use would not likely affect the ambient ozone levels in the unit. Overall combined impacts to air quality related values are anticipated to be minor in both 2002 and 2012. No impairment.
Soundscapes	PWC noise would continue to have minor to moderate, temporary, adverse impacts over the short and long term at most locations on Lake of the Arbuckles and the immediate surrounding area. Impact levels would be related to the	PWC noise would continue to have minor to moderate, temporary, adverse impacts over the short and long term at most locations on Lake of the Arbuckles and the immediate surrounding area. Impact levels would be related to the	PWC noise would continue to have minor, temporary, adverse impacts over the short and long term at many locations on Lake of the Arbuckles and the immediate surrounding area, with potentially moderate impacts	The overall decrease in noise due to the removal of personal watercraft would have a beneficial effect, especially on high-use days when PWC use comprises 20%–30% of total motorized use.

Impact Topic	Alternative A: Continue PWC Use under a Special NPS Regulation	Alternative B: Continue PWC Use under a Special NPS Regulation with Management Restrictions	Alternative C: Continue PWC Use but Limit Area of Use and Implement Other Restrictions	No-Action Alternative — No PWC Use
	number of personal watercraft operating, as well as the sensitivity of other visitors. Over the long term PWC noise levels would be reduced with the introduction of newer engine technologies. Cumulative noise impacts from personal watercraft, motorboats, and other visitors would be minor to moderate because these sounds would be heard occasionally throughout the day; these sounds could predominate on busy days during the high-use season. No impairment.	number of personal watercraft operating, as well as the sensitivity of other visitors. Expanding the no-wake zone around the Buckhorn developed area would have a beneficial effect, although it would not change overall impact types or threshold levels. Over the long term PWC noise levels would be reduced with the introduction of newer engine technologies. Cumulative noise impacts from personal watercraft, motorboats, and other visitors would be minor to moderate because these sounds would be heard occasionally throughout the day, and they could predominate on high-use days. No impairment.	at some high-use areas. Restrictions in alternative C would produce a beneficial effect on the park soundscape, reducing noise levels and periods of potential impact. Cumulative noise impacts from personal watercraft, motorboats, and other visitors would be minor to moderate because these sounds would be heard occasionally throughout the day, and they could predominate on busy days during the high-use season. Impacts would more often be minor rather than moderate. No impairment.	Cumulative noise impacts from motorboats and other visitor activities would be minor to moderate, but there would be no contribution from personal watercraft. No impairment.
Wildlife and Wildlife Habitat	Continued PWC use in all designated areas in Lake of the Arbuckles would result in negligible to minor, temporary impacts on wildlife and waterfowl from PWC-generated noise, physical disturbance and emissions. On a cumulative basis, all visitor activities would continue to have negligible to minor adverse effects on wildlife and wildlife habitat. No impairment.	Alternative B would have similar impacts to alternative A with respect to effects on wildlife. PWC use would have negligible to minor, temporary, adverse effects on wildlife and wildlife habitat. Cumulative impacts on wildlife from all visitor activities would be negligible to minor. No impairment.	Compared to alternative A, alternative C would have some beneficial effect on wildlife and waterfowl as a result of restricting PWC use at certain times and in certain locations, as well as requiring personal watercraft to meet the EPA emission standards by 2005. Direct impacts would be eliminated in all areas closed to PWC use, including a 150-foot buffer all along the shoreline (except for launching areas). Restricting use during early morning and dusk, when wildlife are most abundant and vulnerable, would be beneficial. Similar to the other alternatives, PWC use would have negligible to minor, temporary, adverse impacts on wildlife; however, additional use restrictions would result in beneficial impacts. Cumulative impacts from all visitor activities would be negligible to minor and adverse. No impairment.	Not allowing PWC use on Lake of the Arbuckles would result in a beneficial impact on wildlife and wildlife habitat because interactions between PWC users and wildlife would be eliminated. The minor reduction in noise could result in some animals potentially reinhabiting or using areas that would be closed to PWC use. On a cumulative basis there would be negligible to minor adverse impacts on wildlife and wildlife habitat from other shoreline visitor activities. PWC contribution to overall impacts to wildlife and wildlife habitat would be eliminated. No impairment.
Threatened, Endangered, or Special Concern Species	PWC use may affect, but is not likely to adversely affect, any listed wildlife or plant species. PWC use would not likely adversely affect any of the special status species since interactions would be extremely limited. While some birds could exhibit a stress or flight response because of PWC activities, impacts would be temporary. Long	PWC use may affect, but is not likely to adversely affect, any listed wildlife or plant species. While some disturbance could occur to transient wildlife species from off-season PWC use, the impacts would not be of sufficient duration or intensity to cause adverse impacts. No impacts would occur in areas where PWC use would be prohibited.	PWC use may affect, but is not likely to adversely affect, any listed species. While some disturbance could occur from off-season PWC use, impacts would be not be of sufficient duration or intensity to cause adverse impacts. No impacts would occur in designated areas where PWC use would be prohibited.	There would be no effect on the special status species because of a ban on PWC use. On a cumulative basis impacts from other visitor activities and boating are not likely to adversely affect the listed species, similar to the other alternatives. PWC contribution to overall

Impact Topic	Alternative A: Continue PWC Use under a Special NPS Regulation	Alternative B: Continue PWC Use under a Special NPS Regulation with Management Restrictions	Alternative C: Continue PWC Use but Limit Area of Use and Implement Other Restrictions	No-Action Alternative — No PWC Use
	term water quality effects on the amphipod are not known. Cumulative effects from all park visitor activities are not likely to adversely affect listed wildlife species because they are transient winter residents, and impacts on individual plants would not jeopardize species populations within the park. No impairment.	As described for alternative A, cumulative impacts from all park visitor activities are not likely to adversely affect listed species. Listed wildlife species are transient winter residents, and any impacts on individual plants would not jeopardize species populations within the park. No impairment.	As described for alternative A, cumulative impacts from all park visitor activities are not likely to adversely affect listed species. Listed wildlife species are only transient winter residents, and any impacts on individual plants would not jeopardize species populations within the park. No impairment.	cumulative impacts to protected species would be eliminated. No impairment.
Shorelines and Shoreline Vegetation	PWC use would result in negligible to minor, localized adverse impacts on shoreline vegetation over the short and long term, with either no perceptible changes in plant community size, integrity, or continuity. Cumulative impacts include other sources of shoreline erosion that create impacts greater that those caused by PWC use, including high boat use. Overall, personal watercraft and other sources of cumulative impacts would create negligible to minor, short and long term, adverse impacts on the shoreline or shoreline vegetation. No impairment.	PWC use would have negligible to minor, localized adverse impacts to sensitive shoreline vegetation over the short and long term, with no perceptible changes in plant community size, integrity, or continuity. Monitoring would provide beneficial feedback on the condition of certain areas. Cumulative impacts related to other visitor activities would be the same as alternative A and would be negligible to minor, short and long term, and adverse. There would be no perceptible changes to plant community size, integrity or continuity, now or in the future (2012). No impairment.	Restricting PWC use would result in beneficial impacts to sensitive shoreline vegetation over the short and long term, with no perceptible changes in plant community size, integrity, or continuity. Cumulative impacts related to other visitor activities would be negligible to minor, short and long term, and adverse, the same as for alternative A. There would be a negligible reduction of overall impacts by restricting PWC use. No impairment.	Banning PWC use would result in beneficial impacts to sensitive shoreline vegetation over the short and long term, with no perceptible changes in plant community size, integrity, or continuity. Cumulative impacts related to other visitor activities would be negligible to minor, short and long term, and adverse, the same as for alternative A. There would be a negligible reduction of overall impacts by restricting PWC use. No impairment.
Visitor Experience	Continued PWC use would have negligible to minor adverse impacts on the experiences of most visitors in the short and long term. PWC use would have negligible to minor adverse impacts on other boaters due to increased congestion at popular boat launches. PWC use would have long-term, negligible to minor, adverse impacts on swimmers and those visitors desiring natural quiet because the park currently protects the experiences of these users. Cumulative effects of PWC use, other watercraft, and other visitors would result in negligible to minor, short- and long-term, adverse impacts.	PWC users would experience minor to moderate adverse effects over the short and long term because of management restrictions. Impacts of PWC use on other boaters and visitors (swimmers, anglers, and campers) would be negligible to minor, short and long term, and adverse. Cumulative effects of PWC use, other watercraft, and other visitors would result in negligible to minor, short- and long-term, adverse impacts to most visitors in the park.	Extending PWC area closures would have negligible to minor, short- and long-term, adverse impacts on most users, because most popular use areas would remain open. However, PWC users would experience minor to moderate, short- and long-term, adverse impacts due to increased management restrictions, such as limiting the number of day-use permits and reducing daily use hours or days of operation. The requirement to meet the EPA emission standards by 2005 would have a moderate to major adverse effect on PWC users. Restrictions on PWC use would have beneficial impacts on other boaters and visitors, such as swimmers, anglers, and campers. Cumulative impacts on visitor experiences related to the use of personal watercraft, motorized boats, and other visitor activities would be negligible to minor over the short and long term.	Impacts on PWC users who would no longer be able to ride in the national recreation area would be moderate to major, short and long term, and adverse. The no-action alternative would have a beneficial impact on the experiences of most other visitors because PWC use would be banned. Cumulative impacts would be beneficial as compared to alternative A. On a regional scale the no-action alternative would result in a negligible to minor adverse effect at other waterbodies in the region as a result of PWC users going to other locations to enjoy this activity.

Impact Topic	Alternative A: Continue PWC Use under a Special NPS Regulation	Alternative B: Continue PWC Use under a Special NPS Regulation with Management Restrictions	Alternative C: Continue PWC Use but Limit Area of Use and Implement Other Restrictions	No-Action Alternative — No PWC Use
Visitor Conflicts and Safety	Continued PWC use would have minor to moderate, short- and long-term, adverse impacts on visitor conflicts and safety, particularly in the areas of the launches around The Point, Buckhorn, and Guy Sandy due to the number of visitors and boats present on high-use days, as well as a concentration of conflicting uses. Conflicts at other locations would remain negligible because use is lower and conflicts would be less likely to occur. Cumulative impacts would continue to be minor to moderate for all user groups in the short and long term, particularly near the high-use areas. Cumulative impacts in other segments would be negligible because of reduced use.	Similar to alternative A, continued PWC use would have minor to moderate, short- and long-term, adverse impacts on visitor conflicts and safety, particularly around launches at The Point, Buckhorn, and Guy Sandy, due to the concentration of conflicting uses on high-use days. Conflicts at other locations would remain negligible because conflicts would be less likely to occur. Cumulative impacts related to visitor conflicts and safety would continue to be minor to moderate for all user groups in the short and long term, particularly near high-use areas. Cumulative impacts in other areas would be negligible because of reduced use.	Swimmers and other boaters would experience beneficial impacts under alternative C in areas where PWC use would be restricted, thus helping reduce conflicts and increase safety. Boaters in areas remaining open to PWC use would experience minor to moderate, short- and long-term, adverse impacts similar to alternative A; impacts would be concentrated at localized areas, primarily launches at The Point, Buckhorn, and Guy Sandy. Restricting PWC use would help reduce the potential for conflict and accidents with other users, reducing the cumulative impact to minor and adverse over the short and long term.	Discontinuing PWC use would result in beneficial impacts by reducing visitor conflicts and enhancing safety. PWC-related contributions to overall cumulative impacts to visitor safety would be eliminated; however, visitor safety impacts from other sources would continue to result in minor adverse impacts.
Cultural Resources				
• Archeological Sites, Submerged Resources	Continuing PWC use could have minor adverse impacts on potentially listed archeological sites and submerged resources from possible illegal collection and vandalism. Cumulative impacts on resources that are readily accessible could be minor to moderate adverse, due to the number of visitors and the potential for illegal collection or destruction. No impairment.	Continuing PWC use could have minor adverse impacts on potentially listed archeological sites and submerged resources from possible illegal collection and vandalism, similar to alternative A. Closure of some areas and provisions for monitoring would lessen the likelihood of adverse effects related to PWC use. Cumulative impacts on archeological and submerged cultural resources that are readily accessible could be minor to moderate adverse, due to the number of visitors and the potential for illegal collection or destruction. No impairment.	Continuing PWC use could have minor adverse impacts on potentially listed archeological sites and submerged resources from possible illegal collection and vandalism, similar to alternative A. Closing some areas to use and providing for monitoring would lessen the likelihood of adverse effects related to PWC use. Cumulative impacts on archeological and submerged cultural resources that are readily accessible could be minor to moderate adverse, due to the number of visitors and the potential for illegal collection or destruction. No impairment.	Prohibiting PWC use would have minor beneficial impacts on archeological sites and submerged resources by reducing the potential for illegal collection or damage attributable to PWC users. Cumulative impacts from all visitor activities would continue to be minor to moderate, depending on the accessibility of the resource and the potential for illegal collection or damage. No impairment.
• Ethnographic Resources	This alternative would not impact any ethnographic resources along the shoreline of Lake of the Arbuckles. No cumulative impacts have been identified. No impairment.	This alternative would not impact any ethnographic resources. No cumulative impacts have been identified. No impairment.	This alternative would not impact any ethnographic resources. No cumulative impacts have been identified. No impairment.	Banning PWC use would remove any possible intrusions on ethnographic resources or traditional uses as a result of PWC use. This would be a beneficial impact. No cumulative impacts have been identified. No impairment.
Socioeconomic Effects	No change from current conditions. Impacts on the local and regional economies related to PWC use are not measurable.	No change from current conditions; extending the no-wake zone around the Buckhorn developed area under alternative B would result in a negligible impact. Impacts on the local and regional economies related to PWC use are not measurable.	If PWC use decreased as a result of use restrictions, then the suppliers of PWC accessories and storage would be adversely affected. Lodging establishments, restaurants, gas stations, and other businesses that serve PWC riders would be unlikely to	Banning PWC use under the no-action alternative would have a major, short- and long-term, adverse effect on PWC users in the national recreation area. They could trailer their watercraft to other use areas,

Impact Topic	Alternative A: Continue PWC Use under a Special NPS Regulation	Alternative B: Continue PWC Use under a Special NPS Regulation with Management Restrictions	Alternative C: Continue PWC Use but Limit Area of Use and Implement Other Restrictions	No-Action Alternative — No PWC Use
			experience a substantial reduction in business from any proposed restriction because PWC users at Chickasaw are believed to be primarily day users and because PWC users account for a very small share of total visitation to the area. Impacts on the local and regional economies related to PWC use are not measurable.	but it would be far more inconvenient and expensive. Impacts on the local and regional economies related to PWC use are not measurable.
National Recreation Area Management and Operations				
• Conflicts with State and Local Regulations	State PWC regulations would continue to be enforced within the national recreation area, along with NPS regulations. Continued PWC use would not result in conflicts with state or local regulations. Impacts (including cumulative impacts) would be negligible.	PWC use restrictions would apply only within the national recreation area and would not result in conflicts with state or local PWC regulations or policies. Impacts (including cumulative impacts) would be negligible.	PWC use restrictions would apply only within the national recreation area and would not result in conflicts with state or local PWC regulations or policies. Impacts (including cumulative impacts) would be negligible.	Discontinuing PWC use within the national recreation area would not result in conflict with state PWC regulations or policies. Impacts (including cumulative impacts) would be negligible.
• Enforcement Needs	Continuing PWC use would have moderate adverse impacts on park operations. One additional permanent ranger, plus more funding and equipment, would be needed to regulate existing PWC as well as boating use.	Similar to alternative A, this alternative would have moderate adverse impacts on park operations. One additional permanent ranger, plus more funding, equipment, and educational supplies, would be needed to ensure full compliance with PWC management prescriptions in this alternative.	Similar to alternative A, this alternative would have moderate adverse impacts on park operations. One permanent ranger and two part-time visitor use assistants, along with more funding, equipment, and educational supplies, would be needed to ensure full compliance with PWC location restrictions and management prescriptions included in this alternative.	This alternative would have negligible adverse impacts on park operations. No additional staff, funding, or equipment would be needed to ensure compliance with the PWC ban or to regulate existing boating use, although staff might initially have to spend more time and effort educating visitors until they became fully aware of the PWC ban.

TABLE 5: ANALYSIS OF HOW ALTERNATIVES MEET OBJECTIVES

Issue	Objective	Alternative A — Continue PWC Use under a Special Regulation	Alternative B — Continue PWC Use under a Special Regulation with Additional Management Prescriptions	Alternative C — Continue PWC Use but Limit Area of Use and Implement Other Restrictions	No-Action Alternative — No PWC Use
Water Quality					
The vast majority of personal watercraft in use today are powered by conventional two-stroke, carbureted engines, which discharge as much as 30% of their fuel unburned directly into the water. Hydrocarbons, including benzene, toluene, ethyl benzene, and xylene (BTEX) and polyaromatic hydrocarbons (PAHs), are also released. These discharges have potential adverse effects on water quality.	Manage PWC emissions that enter the water in accordance with NPS anti-degradation policies and goals.	Meets objective under future EPA emission standards.	Meets objective under future EPA emission standards.	Meets objective earlier because of requirement to meet EPA 2006 emission standards in 2005.	Fully meets objective.
Some research shows that PAHs, including those from PWC emissions, adversely affect water quality by means of harmful phototoxic effects on eco-	Protect plankton and other aquatic organisms from PWC emissions	Meets objective under future EPA emission standards.	Meets objective under future EPA emission standards and by expanding	Meets objective earlier because of requirement to meet EPA 2006	Fully meets objective.

Issue	Objective	Alternative A — Continue PWC Use under a Special Regulation	Alternative B — Continue PWC Use under a Special Regulation with Additional Management Prescriptions	Alternative C — Continue PWC Use but Limit Area of Use and Implement Other Restrictions	No-Action Alternative — No PWC Use
logically sensitive plankton and other small water organisms. This in turn can affect aquatic life and ultimately aquatic food chains. The primary concern is in shallow water ecosystems.	and sediment disturbances so that the viability of dependent species is conserved.		no-wake zone in shallow waters around the Buckhorn developed area.	emission standards in 2005 and by expanding no-wake zones in shallow areas.	
Lake of the Arbuckles serves as a potable water supply for the cities of Ardmore, Davis, and Wynnewood, as well as the Wynnewood Refining Company, through water allocations from the Arbuckle Master Conservancy District. Additionally, the city of Dougherty and the Goddard Youth Camp contract with the Water Conservancy District for potable water. PWC emissions may cause impacts on water quality and subsequent concerns from entities using Lake of the Arbuckles as a potable water supply (Arbuckle Master Conservancy District).	Manage PWC emissions so that potable water supplies are not impacted.	Meets objective under future EPA emission standards, in addition to sampling and monitoring of water quality.	Meets objective under future EPA emission standards, in addition to sampling and monitoring of water quality.	Meets objective earlier because of requirement to meet EPA 2006 emission standards in 2005, in addition to sampling and monitoring of water quality.	Fully meets objective.
Air Quality					
Pollutant emissions such as nitrogen oxides and volatile organic compounds from PWC use may adversely affect air quality. PWC emissions could have some localized impacts, particularly if PWC use increased. New technology and implementation of the EPA 2006 emission requirements are designed to reduce some air quality impacts.	Manage PWC activity so that air emissions of harmful compounds do not appreciably degrade ambient air quality.	Meets objective under future EPA emission standards.	Meets objective under future EPA emission standards.	Meets objective earlier because of requirement to meet EPA 2006 emission standards in 2005.	Fully meets objective.
Soundscapes					
PWC-generated noise varies from vessel to vessel. No literature was found that definitively described scientific measurements of personal watercraft noise. Some literature states that all recently manufactured watercraft emit fewer than 80 dB at 50 feet from the vessel, while other sources attributed levels as high as 102 dB without specifying distance. None of this literature fully describes the method used to collect noise data. The National Park Service contracted for noise measurements of personal watercraft and other motorized vessels in 2001 at Glen Canyon National Recreation Area. The results show that maximum PWC noise levels at 82 feet (25 meters) ranged between 68 to 76 dBA. Noise levels for other motorboat types measured during that study ranged from 65 to 86 dBA at 82 feet. Noise limits established by the National Park Service are 82 dB at 82 feet. Visitors 100 feet away from a PWC user may be exposed to approximately 75 dB, which may be more disturbing due to rapid changes in acceleration and direction of noise from a constant source at 90 dB.	Manage noise from PWC use so that visitors' health, safety, and experiences are not adversely affected. By September 2005, 95% of visitors are satisfied with the appropriate facilities, services, and recreational opportunities.	Meets objective. Limited increases in PWC use projected. In the long term watercraft meeting the EPA standards would generate less noise.	Meets objective with expanded no-wake area around the Buckhorn developed area. Limited increases in PWC use projected. In the long term watercraft meeting the EPA standards would generate less noise.	Meets objective with PWC exclusion zones and limited times of operation and by requiring PWC operators to meet EPA 2006 emission standards by 2005, resulting in quieter watercraft.	Fully meets objective.

Issue	Objective	Alternative A — Continue PWC Use under a Special Regulation	Alternative B — Continue PWC Use under a Special Regulation with Additional Management Prescriptions	Alternative C — Continue PWC Use but Limit Area of Use and Implement Other Restrictions	No-Action Alternative — No PWC Use
Wildlife and Wildlife Habitat					
Some research suggests that personal watercraft have a greater impact on waterfowl and nesting birds because of their noise, speed, and ability to access shallow-water areas more readily than other types of watercraft. This may force nesting birds to abandon eggs during crucial embryo development stages and flush other waterfowl from habitat, causing stress and associated behavior changes. Collisions with waterfowl and wildlife may also be of concern.	Protect birds, waterfowl, and other wildlife from the effects of PWC noise.	Meets objective under future EPA emission standards because of quieter watercraft.	Meets objective under future EPA emission standards because of quieter watercraft and expanded monitoring of resource impacts.	Meets objective with PWC exclusion zones, limited times of operation, 2005 date for meeting EPA emission standards, quieter watercraft, and expanded monitoring of resource impacts.	Fully meets objective.
Some research suggests that PWC use impacts wildlife by interrupting normal activities, causing alarm or flight, causing animals to avoid habitat, displacing habitat, and affecting reproductive success. This is thought to be caused by a combination of PWC speed, noise, and ability to access sensitive areas, especially in shallow water. Literature suggests that personal watercraft can access sensitive shorelines, disrupting riparian habitat areas critical to wildlife.	Protect fish and wildlife and their habitats from PWC disturbances.	Meets objective. Limited increases in PWC use projected.	Meets objective with expanded monitoring of resource impacts. Limited increases in PWC use projected.	Meets objective with PWC exclusion zones and expanded monitoring of resource impacts. Limited increases in PWC use projected.	Fully meets objective.
Malignant neoplasms (cancerous lesions) are present on at least one species of fish in Lake of the Arbuckles (gizzard shad, *Dorosoma cepedianum*). Studies indicate environmental contamination or viral origins for non-hepatic (non-liver) neoplasms in fish species. While studies have not identified a cause or causes of the neoplasms, PWC discharges could have potential causal effects for malignant neoplasms.	Protect fish and wildlife from the adverse effects that result from the bioaccumulation of contaminants emitted from personal watercraft.	Meets objective. Current water quality conditions have not been linked to cancer in gizzard shad.	Meets objective. Current water quality conditions have not been linked to cancer in gizzard shad.	Meets objective. Current water quality conditions have not been linked to cancer in gizzard shad.	Fully meets objective.
Threatened, Endangered, and Special Concern Species					
In some areas PWC use is believed to cause harm to threatened or endangered species because the machine's engine, submerged under the water, muffles the 'warning' sounds that some species depend on to escape from imminent danger.	Protect threatened or endangered species and their habitats from PWC disturbances.	Meets objective because such species primarily occur during the off-season for PWC use and the potential impact is minimal.	Meets objective because such species primarily occur during the off-season for PWC use and the potential impact is minimal.	Meets objective because such species primarily occur during the off-season for PWC use and the potential impact is minimal.	Fully meets objective.
Shoreline Vegetation					
PWC users are able to access areas where most other motorcraft cannot go, which may disturb sensitive plant species. In addition, PWC users may land on the shoreline, allowing them to access areas where sensitive vegetation and plant species exist.	Manage PWC use to protect sensitive shoreline areas from visitor impacts related to such use.	Meets objective in areas where PWC users are limited to 5 mph within 150′ of the shoreline.	Meets objective in areas where PWC users are limited to 5 mph within 150′ of the shoreline and with expanded monitoring of resource impacts.	Fully meets objective by restricting PWC use within 150′ of the shoreline (except for certain access areas), monitoring for sensitive species, and implementing PWC exclusion zones.	Fully meets objective.

Issue	Objective	Alternative A — Continue PWC Use under a Special Regulation	Alternative B — Continue PWC Use under a Special Regulation with Additional Management Prescriptions	Alternative C — Continue PWC Use but Limit Area of Use and Implement Other Restrictions	No-Action Alternative — No PWC Use
Some research shows that personal watercraft create a wake at slower speeds than most larger boats, and when driven close to shore their wakes can lead to erosion and ultimately shoal formation.	Manage PWC use to protect sensitive shoreline areas from any potential erosion caused by PWC activity.	Meets objective in areas where PWC users are limited to 5 mph within 150′ of the shoreline.	Meets objective in areas where PWC users are limited to 5 mph within 150′ of the shoreline and with expanded monitoring of resource impacts.	Fully meets objective by restricting PWC use within 150′ of all shorelines (except for certain access areas), monitoring for the sensitive species, and implementing PWC exclusion zones.	Fully meets objective.
Visitor Experience					
Some research suggests that personal watercraft are viewed by some segments of the public as a nuisance due to their noise, speed, and overall environmental effects. However, others believe that personal watercraft are no different from other motorcraft and that users have a right to enjoy the sport.	Minimize potential conflicts between PWC users and park visitors. By September 2005, 95% of visitors are satisfied with the appropriate facilities, services, and recreational opportunities.	Meets objective due to low reported visitor conflicts with continued PWC use.	Meets objective due to low reported visitor conflicts with continued PWC use.	Meets objective because PWC use continues, but with additional restrictions to further minimize the potential for conflicts.	Does not meet objective. Would lower the satisfaction of PWC users.
Chickasaw National Recreation Area is legislatively charged with providing "for public outdoor recreation use and enjoyment of Arbuckle Reservoir and land adjacent thereto." PWC management may affect the enhancement of recreational opportunities or cause changes in the methods and types of recreational activities occurring within the park.	Manage PWC use consistent with the enabling legislation, and provide an appropriately wide range of recreational activities consistent with protecting conservation values.	Meets objective by allowing PWC use.	Meets objective by allowing PWC use.	Meets objective by allowing PWC use.	Does not meet objective. Banning PWC use would limit range of recreational activities consistent with the enabling legislation.
Visitor Conflicts and Safety					
In 1996 personal watercraft represented 7.5% of state-registered recreational boats but accounted for 36% of boating accidents. In part, this may be a boater education issue, i.e., inexperienced riders lose control of the craft; yet it also is a function of the PWC operation, i.e., no brakes or clutch. When drivers let up on the throttle to avoid a collision, steering becomes difficult.	Minimize or reduce the potential for PWC user accidents.	Meets objective. There have only been 12 PWC-related accidents between 1995 and August 2002.	Meets objective by increasing enforcement of new restrictions, establishing a self-regulatory PWC user group, and establishing a voluntary user education program.	Meets objective by increasing enforcement of new restrictions, establishing a self-regulatory PWC user group, and establishing a mandatory user education program.	Fully meets objective.
Personal watercraft, due to their ability to reach speeds in the 60 mph range and their ability to access shallow areas, can create wakes that pose a conflict and safety hazard to other users, such as canoeists and kayakers.	Minimize or reduce the potential for safety conflicts between PWC users and other water recreationists.	Meets objective. There have only been 12 PWC-related accidents between 1995 and August 2002.	Meets objective by establishing a self-regulatory PWC user group and establishing a voluntary user education program.	Meets objective by establishing a self-regulatory PWC user group and a mandatory user education program.	Fully meets objective.
Cultural Resources					
Chickasaw has cultural resources listed on, or potentially eligible for listing on, the National Register of Historic Places near Lake of the Arbuckles. Known sites may indicate the presence of other, unknown sites along the shores of the lake. Shoreline erosion and uncontrolled visitor access may affect	Manage PWC use and access to protect cultural resources both unknown and known, including Native American sacred sites.	Meets objective because cultural resources protected by existing regulations.	Meets objective with expanded monitoring of resource impacts, closing sites as needed, and voluntary education program.	Fully meets objective with monitoring of resource impacts, closing sites as needed, and mandatory education program.	Fully meets objective.

Issue	Objective	Alternative A — Continue PWC Use under a Special Regulation	Alternative B — Continue PWC Use under a Special Regulation with Additional Management Prescriptions	Alternative C — Continue PWC Use but Limit Area of Use and Implement Other Restrictions	No-Action Alternative — No PWC Use
these resources since riders are able to access / beach / launch in areas less accessible to most motorcraft.					
Socioeconomic					
National PWC ownership increased every year between 1991 and 1998; the rate of annual increase peaked in 1994 at 32% and dropped slightly in 1999, 2000, and 2001.	Work cooperatively with concessioners and local businesses that rent or sell personal watercraft.	Meets objective. No local businesses impacted.	Meets objective. No local businesses impacted.	Meets objective. No local businesses impacted.	Meets objective but PWC use ban could affect PWC sales or rentals.
National Recreation Area Management and Operations					
Some states and local governments have taken action, or are considering taking action, to limit, ban, or otherwise manage PWC use. While the park may be exempt from these local actions, consistency with state and local plans must be evaluated.	Seek cooperation with state entities that regulate PWC use.	Fully meets objective. No conflicts between state and local regulations.	Fully meets objective.	Fully meets objective.	Fully meets objective.
Personal watercraft, due to their increased accident rates and visitor safety conflicts, may require additional park staff to enforce standards and limits.	Provide a safe and healthful park environment for park visitors.	Meets objective due to existing state regulations.	Meets objective with increased enforcement of new restrictions.	Meets objective with increased enforcement of new restrictions.	Fully meets objective.

AFFECTED ENVIRONMENT

WATER QUALITY

WATERSHED

The reservoir in Chickasaw, which is known as Lake of the Arbuckles, was constructed by the Bureau of Reclamation starting in 1964. Final storage began in January 1967 (USACE 1996). The reservoir was created to provide public water to the cities of Davis, Wynnewood, and Sulphur, plus the Wynnewood Refining Company (Robinson 2002b). The reservoir is located at the confluence of the Buckhorn, Guy Sandy, and Rock Creeks (Rock Creek is a tributary of the Washita River). Total drainage area for Lake of the Arbuckles is 126 square miles and includes the drainages of Sandy Creek and Buckhorn Creek (U.S. Army Corps of Engineers [USACE] 1996). Springs feed water directly into the reservoir, as well as feeding tributaries to the reservoir (S. Jolly, Arbuckle Master Conservancy District, pers. comm., T. Campbell, URS, Sept. 23, 2002).

At conservation pool elevation (872 feet), the reservoir covers 2,350 acres and holds 72,400 acre-feet of water. Average depth is 31 feet and maximum depth is 75 feet at conservation pool. The current elevation and corresponding volume is essentially the same as the conservation pool. As of September 23, 2002, the water elevation was 872.48 feet, volume was 73,480 acre-feet, and the area covered was 2,375 acres (S. Jolly, Arbuckle Master Conservancy District, pers. comm., T. Campbell, URS, Sept. 23, 2002).

Although only one set of depth profile data is available, it is possible that a thermocline could become established in Lake of the Arbuckles during the warmer months of the year, which would reduce the effective mixing volume the lake (P. Koenig, NPS, pers. comm., T. Campbell, URS, Sept. 30, 2002). The depth and strength of any thermocline would vary with year and time of year, typically becoming established in the spring and continuing through the early fall. It is unlikely that the no-wake zones have themoclines because of their shallow depths.

RESERVOIR OPERATION

Water in Lake of the Arbuckles is used for municipal water supply, flood control, recreation, and fish and wildlife (USACE 1996). The Arbuckle Master Conservancy District manages the use and distribution of water from Lake of the Arbuckles. Currently, Lake of the Arbuckles serves as a potable water supply for the cities of Ardmore, Davis, Sulphur, and Wynnewood, as well as the Wynnewood Refining Company, through water allocations from the Arbuckle Master Conservancy District. Additionally, the city of Dougherty and the Goddard Youth Camp contract with the conservancy district for potable water.

Current water use from the reservoir is estimated to be 34.1 acre-feet per day. Of that, approximately 8 acre-feet per day are pumped from the reservoir and 26.1 acre-feet per day are gravity-fed (S. Jolly, Arbuckle Master Conservancy District, pers. comm., T. Campbell, URS, Sept. 23. 2002). Ardmore, one of the biggest consumers of water from the reservoir, uses 8–10 million gallons per day (24.6 and 30.7 acre-feet per day) during the summer (Robinson 2002b).

OKLAHOMA WATER QUALITY STANDARDS

State-Designated Stream Segments and Uses

In accordance with EPA guidelines, the Oklahoma Water Resources Board (OWRB) has classified major stream segments within the state according to designated uses (OWRB 2002). Chickasaw National Recreation Area and Chickasaw Wildlife Management Area, including Rock Creek, Lake of the Arbuckles, and Guy Sandy Creek (all are tributaries to the Washita River) are within Water Quality Management Segment 310800. Designated beneficial uses for this segment are:

- Public and private water supply
- Warm water aquatic community
- Class 1 agriculture irrigation
- Primary body contact recreation
- Aesthetics
- Sensitive public and private water supplies

Antidegradation Policy. The state-established antidegradation policy ("Oklahoma's Water Quality Standards, sec. 785: 45-3-1; OWRB 2002) is designed to protect water quality at existing levels and to prevent a deterioration of water quality below achievable uses for a given stream segment. The antidegradation policy applies to Lake of the Arbuckles (WQMS 310800) under two paragraphs:

1. *Application to outstanding resource waters* — These waters may include national and state parks and wildlife management areas. (Lake of the Arbuckles is a national recreation area and a wildlife management area.)
2. *Application to beneficial uses* — No water quality degradation that will interfere with the attainment or maintenance of an existing or designated beneficial use shall be allowed. (The six beneficial uses for Lake of the Arbuckles Lake are listed above.)

Numeric Standards. Oklahoma has water quality standards for toxic materials and the protection of aquatic life and human health. For freshwater, standards are provided for benzene only, among the gasoline-related organic compounds evaluated (benzo(a)pyrene, naphthalene, 1-methyl naphthalene, benzene, and MTBE). The standards for benzene are included in Table 6.

TABLE 6: STATE OF OKLAHOMA WATER QUALITY STANDARDS FOR ORGANIC POLLUTANTS

Chemical	Fish and Wildlife Propagation (acute) (µg/L)	Fish and Wildlife Propagation (chronic) (µg/L)	Ingestion of Water and Fish (µg/L)	Ingestion of Fish Only(µg/L)
Benzene	--	2200	12	714

SOURCE: OWRB 2002, appendix G, table 2.

No standards for benzene or any other evaluated organic compounds are provided specifically for public and private water supply. No segment-specific standards are provided for organic compounds associated with gasoline.

RESERVOIR WATER QUALITY DATA

A large amount of water quality data have been collected for standard pollutants in Lake of the Arbuckles and the principal drainages to the reservoir. A compilation of the data from six USEPA databases is presented in "Baseline Water Quality Data, Inventory and Analysis — Chickasaw National Recreation Area" (NPS 1997a). Water quality data were compiled from 28 monitoring stations (20 within the park) from 1951 through 1995, with the majority of data collected from 1967 through 1994. The principal water quality parameters compiled and summarized include temperature, dissolved oxygen, pH, turbidity, coliform bacteria, chloride, nitrate, sulfate, metals, and selected pesticides/herbicides. Additional parameters such as conductance, transparency, alkalinity, and toxic elements (i.e., metals) were measured at some monitoring stations. Data for the organic compounds used in the analysis of water impacts from PWC use (e.g., benzene, PAHs, MTBE) were not available in this report.

In a study of the potential causes of cancerous lesions in gizzard shad (*Dorosoma cepedianum*), no carcinogenic compounds were detected by means of gas chromatograph–mass spectrometry in sediment or water samples collected from Lake of the Arbuckles (Ostrander 2000).

Although the Arbuckle Master Conservancy District manages use and distribution of water from Lake of the Arbuckles, the district does not monitor water quality of the supplied water (S. Jolly, Arbuckle Master Conservancy District, pers. comm., T. Campbell, URS, Sept. 23, 2002). Water quality parameters of interest (e.g., gasoline constituents of PAHs and BTEX) are not monitored by the municipalities served by the district, and the Oklahoma Water Resources Board also does not have any water quality data on these constituents (P. Koenig, NPS, pers. comm., T. Campbell, URS, Sept. 30, 2002).

AIR QUALITY

Chickasaw National Recreation Area is in a sparsely populated area of Murray County in southern Oklahoma. Light manufacturing and tourism are the primary industries in the region. Air quality within the region is currently moderate to good and meets current state and federal standards. Prevailing regional winds are generally from the south.

The Air Quality Division of the Oklahoma Department of Environmental Quality (Oklahoma DEQ) is responsible for monitoring and evaluating air quality in the state. The Air Quality Division has adopted the federal national ambient air quality standards (NAAQS) for criteria pollutants in Oklahoma. These standards are met at all monitored locations throughout the state, and are shown in parts per million (ppm) in Table 7. The Air Quality Division implements the U.S. EPA standards for manufacturers of personal watercraft and has no more stringent requirements for this type of source.

TABLE 7: NATIONAL AMBIENT AIR QUALITY STANDARDS

Primary Standards (Human Health)			Secondary Standards (Air Quality Related Values)	
Pollutant	Average Type	Concentration[a]	Average Type	Concentration[a]
CO	8-hour[b]	9 ppm (10 mg/m^3)	No secondary standard	
	1-hour[b]	35 ppm (40 mg/m^3)	No secondary standard	
Pb	Maximum quarterly average[h]	1.5 µg/m^3	Same as primary standard	
NO_2	Annual arithmetic mean[h]	0.053 ppm (100 µg/m^3)	Same as primary standard	

Primary Standards (Human Health)			Secondary Standards (Air Quality Related Values)	
Pollutant	Average Type	Concentration[a]	Average Type	Concentration[a]
O_3 (implementation of 8-hour standard not currently final	1-hour[cj]	0.12 ppm (235 µg/m^3)	Same as primary standard	
	8-hour[l]	0.08 ppm (157 µg/m^3)	Same as primary standard	
PM_{10}	Annual arithmetic mean[d] 24-hour[e]	50 µg/m^3 150 µg/m^3	Same as primary standard	
$PM_{2.5}$ (implemented but not currently final)	Annual arithmetic mean[d,f] 24-hour[g]	15 µg/m^3 65 µg/m^3	Same as primary standard	
SO_2	Annual arithmetic mean[h]	0.03 ppm (80 µg/m^3)	3-hour[b]	0.50 ppm
	24-hour[b]	0.14 ppm (365 µg/m^3)		(1300 µg/m^3)

a. Parenthetical value is an approximately equivalent concentration.
b. Not to be exceeded more than once per year.
c. Attained when the expected number of days per calendar year with maximum hourly average concentrations above 0.12 ppm is equal to or less than 1, as determined according to Appendix H of the O_3 NAAQS.
d. Not to be exceeded by the 3-year average of the annual mean concentrations.
e. Not to be exceeded by the 3-year average of the annual 99th percentile concentrations.
f. May be spatially averaged over several "community-oriented" sites in an area.
g. Not to be exceeded by the 3-year average of the annual 98th percentile concentrations.
h. Never to be exceeded.
i. Not to be exceeded by the 4th highest annual value averaged over a three-year period.
j. Revoked for all Oklahoma counties on December 29, 1997.

The Air Quality Division was contacted directly about air quality in the area of Chickasaw. The nearest monitoring site to Chickasaw is the Lake Murray monitoring station. This site was established in 2000 and monitors 8-hour average ozone levels. Prior to this site being established, the Talihuna site was the closest to Chickasaw; it monitored for the 1-hour ozone standard. This and all other sites in the state are below the 1-hour national ambient air quality standard for ozone. The four highest maximum 8-hour ozone levels at Lake Murray during 2002 were 0.097 ppm (Sept 13), 0.088 ppm (May 15), 0.080 ppm (Mar. 13), 0.078 ppm (June 23). Three of these values exceed the 8-hour standard value of 0.08 ppm; however, the form of compliance with the standard was not finalized as of 2002. The 8-hour ozone standard is more stringent than the current 1-hour standard (Oklahoma DEQ 2002).

The National Park Service maintains records of ozone levels measured as SUM06, which provide an indication of overall regional ozone exposure. The SUM06 data are based the three-month highest measured values averaged over a five-year period, and obtained during daylight hours. According to information from the NPS Air Resources Division, current values indicate regional ozone levels in the area of Chickasaw are between 19 and 25 ppm-hours. Review of monitoring data show that ozone originating south of Chickasaw in industrial regions of Texas such as the Dallas-Fort Worth area is being transported north and affecting southern Oklahoma in the area of the unit.

Visibility as indicated by fine particulate matter less than 2.5 microns in aerodynamic diameter ($PM_{2.5}$) in the area of Chickasaw is generally good (US EPA 2000c).

SOUNDSCAPES

Soundscapes include both natural and human components. Natural soundscapes would include all naturally occurring sounds such as waves on the shoreline, running water, bird calls, wind blowing through trees, or thunder. It also includes “natural quiet” that occurs in the absence of natural or human caused

sound. The opportunity to experience natural sounds is an enjoyable part of some visitor experiences at the recreation area.

Common human-caused sounds at Chickasaw include engines from personal watercraft and other vessels, vehicle noise, human vocalizations, radios and other sounds generated by people picnicking and camping. Human sounds are not unexpected or inappropriate at the recreation area, but are a part of the overall soundscape in an area where water activities, picnicking, camping, and other recreational use are part of the purpose of the park. Evaluation of the appropriateness of human sounds is evaluated by considering visitor expectation, management guidelines, resource sensitivity, and park purpose.

NATURAL AND HUMAN NOISE LEVELS

Noise is generally defined as an unwanted or intrusive sound. Sounds are described as noise if they interfere with an activity or disturb the person hearing them. Sound is measured in a logarithmic unit called a decibel (dB). Since the human ear is more sensitive to middle and high frequency sounds than to low frequency sounds, sound levels are weighted to reflect human perceptions more closely. These "A-weighted" sounds are measured using the decibel unit dBA. Table 8 illustrates common sounds and the measured sound level.

TABLE 8: SOUND LEVEL COMPARISON CHART

Decibels	How it Feels	Equivalent Sounds
140-160	Near permanent damage level from short exposure	Large caliber rifles (e.g., .243, 30-06)
130-140	Pain to ears	.22 caliber weapon
100	Very loud	Air compressor at 20 feet; garbage trucks and city buses
	Conversation stops	Power lawnmower; diesel truck at 25 feet
90	Intolerable for phone use	Steady flow of freeway traffic; 10 HP outboard motor; garbage disposal
80		Muffled Jet ski at 50 feet; automatic dishwasher; near drilling rig; vacuum cleaner
70		Drilling rig at 200 feet; window air conditioner outside at 2 feet
60	Quiet	Window air conditioner in room; normal conversation
50	Sleep interference	Quiet home in evening; drilling at 800 feet
		Bird calls
40		Library
30		Soft whisper
20		In a quiet house at midnight; leaves rustling

SOURCE: Modified from Final Environmental Impact Statement, Miccosukee 3-1 Exploratory Well, Broward County, Florida (U.S. Department of the Interior).

For the average human a 10 dB increase in the measured sound level is subjectively perceived as being twice as loud, and a 10 dB decrease is perceived as half as loud. The decibel change at which the average human would indicate that the sound is just perceptibly louder or perceptibly quieter is 3 dB. There is generally a 6 dB reduction in sound level for each doubling of distance from a noise source due to spherical spreading loss (e.g., if the sound level at 25 feet from a PWC was 86 dB, the sound level at 50 feet would be expected to be 80 dB, at 100 feet 74 dB, etc.).

Many factors affect how an individual responds to noise. Primary acoustical factors include the sound level, the distribution of sound levels across the frequency spectrum, and the duration (and other time-related factors such as how often it occurs, and timing sensitivity) of the sound. Secondary acoustical factors include the spectral complexity, sound level fluctuations, frequency fluctuation, rise-time of the noise, and localization of the noise source (Mestre Greve Associates 1992).

Non-acoustical factors also play a role in how an individual responds to sounds. Non-acoustical factors vary from the past experience and adaptability of an individual to the predictability of when a noise will occur. The listener's activity will also affect how he/she responds to noise.

Personal watercraft and outboard motors are similar in the actual noise level they generate (in terms of decibels), which is generally around 80 dB or less at 50 feet from a motorized boat or personal watercraft (US EPA 1974) but can range from below 80 dB to as much as 102 dB (Sea-Doo 2000; Bluewater Network 2001). However, unlike motorboats, personal watercraft are highly maneuverable and are used for stunts and acrobatics, often resulting in quickly varying noise levels due to changes in acceleration and exposure of the jet exhaust when crossing waves. The frequent change in pitch and noise levels, especially if operated closer to land, make the noise from personal watercraft more noticeable to human ears (Asplund 2001).

Specific areas within the park where activities may be sensitive to noise include campgrounds, picnic areas, and hiking trails. This would include The Point and Buckhorn campgrounds and the Fishing Rock and Lake View trails. Noise sensitive activities that may occur throughout the lake and immediate area include boat and shoreline fishing, and wildlife watching. The Point and Buckhorn picnic and camping areas are locations where human-caused noises are most evident. Other locations in the recreation area such as the Travertine Nature Center and Veterans Lake are far enough away from Lake of the Arbuckles that PWC noise is not an issue.

Noise related to personal watercraft, as well as other motorized craft, and sounds related to human activity are typically highest during the summer, especially at The Point and the Buckhorn developed area, where most PWC users launch.

VISITOR RESPONSES TO PWC NOISE

Many factors affect how an individual responds to noise. Primary acoustical factors include the sound level, its frequency, and duration. Secondary acoustical factors include the spectral complexity, sound level fluctuations, frequency fluctuation, rise-time of the noise, and localization of the noise source (Mestre Greve Associates 1992).

Non-acoustical factors also play a role in how an individual responds to sounds. These factors vary from the past experience and adaptability of an individual to the predictability of when a noise will occur. The listener's activity also affects how he/she responds to noise. For example, PWC users who are picnicking near the shore and can hear the sounds of other personal watercraft may not find the sound bothersome, but non-PWC users in the same location could be annoyed. On busy summer weekends nearly half the vessels on the water at Chickasaw are personal watercraft, and their use has become an expected part of the soundscape for many visitors.

Personal watercraft generate noise that varies in pitch and frequency due to the nature of their construction and use. The two-stroke engines are often used at high speeds, and the craft bounce along the top of the water such that the motor discharges noise below and above the water surface. To recreation area visitors this irregular noise may be more annoying that that of a standard motorboat cruising along the shoreline, even though the maximum noise levels may be similar for the two watercraft (approximately 80 to 90 dBA at 50 feet). Additionally, visitors who expect to experience natural quiet may consider the irregular noise of personal watercraft more annoying, especially if the craft is operating in one location for extended periods of time.

WILDLIFE AND WILDLIFE HABITAT

Chickasaw is located in an ecotone, where two different ecosystems meet — the eastern woodlands and the western prairies. As a result, abundant food and shelter are available to animals. Forest communities are found along the rivers, and prairies dominate the upland area. Fire suppression in the prairie has encouraged the encroachment of shrubs and drought-tolerant trees. Overgrazing has also encouraged invasion by nongrass species, including prickly pear and yucca.

The forest and prairie communities provide a variety of habitats for diverse wildlife populations in Chickasaw. The number of mammals, amphibians, reptiles, and fish in the national recreation area is extensive. Small animals are most common in the lowland areas along the creeks. Many amphibians congregate by the streams and springs, while some reptiles frequent the creeks.

Hunting is allowed in designated areas of Chickasaw. A variety of game are hunted, including deer, quail, turkey, squirrel, rabbit, dove, ducks and geese (NPS 2002a).

MAMMALS

The National Park Service estimates that 40 species of mammals occur in Chickasaw (see Table 9). Common mammals include the white-tailed deer, armadillo, opossum, eastern cottontail rabbit, jackrabbit, beaver, raccoon, muskrat, fox squirrel, striped skunk, short-tailed shrew, and eastern mole. Predators include the bobcat, coyote, and gray fox, which emerge at night to hunt (NPS 1997b).

The habitats of most mammals occur in lowland forests where food is abundant. These species are not commonly found along the shoreline of Lake of the Arbuckles, and they would move to the interior if disturbed by noise or watercraft activities. No critical habitat occurs within 200 feet of the shore.

BIRDS

More than 100 species of birds have been recorded in Chickasaw. The most common birds are the cardinal, blue jay, robin, wild turkey, bobwhite quail, dove, various sparrows, and woodpeckers. Common raptors include the northern sparrow hawk and the northern barred owl. Ducks and geese are common during fall and spring migrations (NPS 1997b).

Most of the birds identified as having habitat within the impact analysis area have the ability to move from the shoreline if temporarily disturbed by noise or watercraft activities.

FISH

Species of game fish are commonly found in Lake of the Arbuckles include bass (largemouth, small-mouth, spotted, and white), carp, blue gill, sunfish and white crappie (NPS 1997b). Other species present in Lake of the Arbuckles include gizzard shad, threadfin shad, blue catfish, redhorse, freshwater drum, and spotted gar (Ostrander 2000). Fishing is allowed in Lake of the Arbuckles, primarily for black bass (largemouth, spotted, and smallmouth).

Malignant neoplasms (cancerous lesions) are present on at least one species of fish, gizzard shad, in Lake of the Arbuckles (NPS 2002a). During 1998 to 2000, 13 non-shad species were sampled and no tumors were found on the fish. About 22% of gizzard shad residing in the lake exhibit malignant neoplasms after a decade of study. However, the data suggest that the lake is relatively clean and free of causative agents,

TABLE 9: WILDLIFE KNOWN TO OCCUR AT CHICKASAW NATIONAL RECREATION AREA

Mammals			
Armadillo	Eastern pipistrelle	Long-tailed weasel	Red fox
Badger	Easter mole	Mink	Short-tailed shrew
Beaver	Eastern wood rat	Muskrat	Southern flying squirrel
Big brown bat	Evening bat	Nine-banded armadillo	Spotted skunk
Bison	Fox squirrel	Northern grasshopper mouse	Striped skunk
Black-tailed jackrabbit	Gray fox	Norway rat	Swamp rabbit
Bobcat	Gray squirrel	Opossum	Thirteen-lined ground squirrel
Brush mouse	Hispid cotton rat	Pine vole	White-footed mouse
Coyote	House mouse	Plains pocket gopher	White-tailed deer
Deer mouse	Jackrabbit	Raccoon	
Eastern cottontail rabbit	Least shrew	Red bat	
Amphibians			
Bullfrog	Gray treefrog	Plains spadefoot	Strecker's chorus frog
Blanchard's cricket frog	Great plains toad	Red-spotted toad	Tiger salamander
Common toad	Hurter's spadefoot	Small mouthed salamander	Western chorus frog
Couch's spadefoot	Plains green toad	Southern leopard frog	Western narrow-mouthed toad
Dwarf American toad	Plains leopard frog	Spotted chorus frog	
Reptiles			
Alligator snapping turtle	Fence lizard	Ouachita map turtle	Spotted whiptail
Black rat snake	Flat-headed snake	Pallid spiny softshell	Stinkpot
Blotched water snake	Five-lined skink	Prairie kingsnake	Three-toed box turtle
Broad-banded copperhead	Graham's crayfish snake	Prairie ringneck snake	Texas blind snake
Broad-headed skink	Great plains ground snake	Rattlesnake	Texas brown snake
Bullsnake	Great plains rat snake	Razor-backed musk turtle	Texas horned lizard
Central lined snake	Great plains skink	Red-eared slider	Texas night snake
Collard lizard	Ground skink	Red-sided garter snake	Timber rattlesnake
Common snapping turtle	Louisiana milk snake	Rough earth snake	Western coachwhip
Diamond-backed water snake	Mississippi mud turtle	Rough green snake	Western cottonmouth
Dusky hognose snake	Missouri slider	Six-lined racerunner	Western diamondback
Eastern coachwhip	Mountain blind snake	Slender glass lizard	Western earth snake
Eastern yellow-bellied racer	Northern water snake	Southern prairie skink	Western pigmy rattlesnake
Eastern hognose snake	Ornate box turtle	Speckled kingsnake	Western ribbon snake
			Yellow mud turtle

SOURCE: NPS 2002a.

such as aromatic hydrocarbons, typically linked with cancer in fish. The environmental or viral cause of the neoplasms is not known (Ostrander 2000).

AMPHIBIANS AND REPTILES

Chickasaw has 19 known species of amphibians and 57 species of reptiles (see Table 9). Amphibian species include bullfrog, leopard frog, and small-mouthed salamander. Reptiles in the region are represented by a variety of turtles, lizards and snakes. Poisonous snakes include the copperhead, cottonmouth, and diamond and timber rattlesnakes (NPS 1997b). The alligator snapping turtle, which is the largest freshwater turtle in the world, is considered a rare species in Murray County (USFWS 2002)

AQUATIC INVERTEBRATES

Chickasaw has not been surveyed for aquatic invertebrates. Generally, the abundance and type of organisms present depend on the water quality and habitat conditions within Lake of the Arbuckles. The shoreline has little to no aquatic vegetation, so little habitat is available for aquatic invertebrates. Thus, the diversity and abundance of invertebrates along the shoreline is expected to be low, with most organisms associated with creek mouths and interior wetlands.

THREATENED, ENDANGERED, OR SPECIAL CONCERN SPECIES

WILDLIFE SPECIES

Wildlife species listed by the U.S. Fish and Wildlife Service and the Oklahoma Department of Wildlife Conservation, which may occur in or near Chickasaw, are listed in Table 10. The U.S. Fish and Wildlife Service lists three threatened or endangered species and two rare species known to occur in Murray County (USFWS 2002; see appendix C).

TABLE 10: FEDERALLY PROTECTED SPECIES AT CHICKASAW NATIONAL RECREATION AREA

Common Name	Scientific Name	Federal Status	State Status*	Observed at Chickasaw	Habitat Present at Shoreline
Bald eagle	*Haliaeetus leucocephalus*	T	E	X	X
Interior least tern	*Sterna antillarum*	E		X	
Whooping crane	*Grus americana*	E		X	X
Alligator snapping turtle	*Macroclemys temminckii*		SC	X	X
Oklahoma cave amphipod	*Allocrangonyx pelluscidus*		SC		

SOURCES: USFWS 2002; Oklahoma National Heritage Inventory 2001.

E = Endangered Species; T = Threatened Species, SC = Special Concern Species

All three federally protected species have been observed at Chickasaw. Bald eagles are common winter residents from November through March, and they have been documented roosting and foraging on the lake since 1990 (NPS 1997b). Bald eagles could potentially use Chickasaw for nesting (USFWS 2002). The whooping crane is an occasional winter resident, although cranes were sighted on October 6, 2002, flying low over the Rock Creek arm of Lake of the Arbuckles (NPS 2002c). According to the U.S. Fish and Wildlife Service, the whooping crane could use Chickasaw during spring (April to May) or fall (October to November) migration, although this is unlikely (USFWS 2002). The least tern is uncommon and the critical habitat is not prevalent at Chickasaw. None of the three federally listed species are known to nest or breed in the national recreation area.

The alligator snapping turtle and the Oklahoma cave amphipod are considered rare species, i.e., their abundance is known to be declining throughout all or a portion of their range. These species are not legally protected under the Endangered Species Act. The alligator snapping turtle is known to occur at Chickasaw. Although there have not been any recent confirmed sightings, the likely habitat area is in the vicinity of Guy Sandy Creek. Female turtles nest on shore between April and June. The Oklahoma cave amphipod, also known as a water flea, could potentially occur in the caves near the lakeshore. However, there have been no confirmed sightings, and no studies have been conducted to determine if the amphipod exists at Chickasaw.

PLANT SPECIES

According to the U.S. Fish and Wildlife Service, there are no known federally listed plant species in Chickasaw. There is no state list of special status plant species that are legally protected (see appendix C). Nine known species of special concern that are listed by the Oklahoma National Heritage Inventory and have been found at the park (Hoagland et al. n.d.), as listed in Table 11.

TABLE 11: STATE PLANT SPECIES OF CONCERN AT CHICKASAW NATIONAL RECREATION AREA

Common Name	Scientific Name
Pincushion Cactus	*Corypantha vivipara*
Lace Cactus	*Echinocereus reichenbachii*
Woodland Sedge	*Carex cephalophora*
Whitesheath Sedge	*Carex hyalina*
Black Dalea	*Dalea frutescens*
Rock Scurfpea	*Psoralea reverchonii*
Short Lobe Oak	*Quercus durandii var. breviloba*
Ozark Dropseed	*Sporobolus ozarkanus*
Oklahoma Beardtongue	*Penstemon oklahomensis*

SOURCE: Hoagland et al. n.d.

SHORELINE VEGETATION

Regional topography provides the broad context for the existing shoreline vegetation at Chickasaw. Because of a range of hills called the Arbuckle Mountains, some shoreline consists of steep-sided limestone and conglomerate hills. The northwest portion of the recreation area is transitional to the redbed plains and has low rolling hills with gentle slopes (Hoagland et al. n.d.). The Chigley-Naru soil complex is the most common along the shoreline; slopes range from 5% to 30%, and the soil erosion potential is moderate to moderately high (Soil Conservation Service 1984). The shoreline of Lake of the Arbuckles includes areas of upland forest with mature trees, shrub communities, littoral zone emergent marsh, rocky shore, unvegetated shoals, and developed facilities.

Chickasaw lies in a transitional zone between the eastern deciduous forest and the mixed grass or mid grass type prairie / grassland. More than 600 different plant species have been identified in the recreation area. In the Platt district, the original landscape has been altered by the planting of trees, shrubs, and turf grasses, and by the building of ponds and waterfalls. The area is bisected with roadways and utility lines, and campgrounds and other structures are present. Some areas of shoreline contain cultivated zones of mowed lawns along roadways, picnic areas, campgrounds, and buildings.

Common forest species adjacent to the shoreline include sycamore, pecan, hickory, eastern red cedar (an exotic), dogwood, and redbud, along with oak, elm, ash, and sumac. Southern cottonwood, southern hackberry, and black willow are present adjacent to creek inlets.

Common grassland species adjacent to the shoreline include hairy gramma, little bluestem, beard grass, purple threeawn, hairy tall dropseed, yellow Indian grass, big bluestem, sideoats grama, and switch grass.

Aquatic vegetation occurs with a patchy distribution around the shoreline. In many areas of the lake steep slopes, lake depths, and wave action prevent the development or limit the areal extent of aquatic vegetative communities. Palustrine emergent wetlands containing nonwoody aquatic plants are more common near the inlets of Guy Sandy, Rock, and Buckhorn Creeks. However, spotty occurrences of nearshore emergent vegetation occur throughout the recreation area and include arrowhead, various sedges, and rushes. Submerged and floating-leaved macrophytes include water cress, coontail, naiad, water lily, duckweed, and various species of pondweed (Hoagland et al. n.d.).

Erosion is caused primarily by high winds, wave action, and human use. Areas of existing erosion include shorelines near camping areas and boat launches, private properties where landowners moor watercraft, and shallow areas and small arms of larger waterbodies such as Rock Creek (S. Burrough, NPS, pers. comm., R. Wieland, URS, Oct. 2, 2002). Eroded areas are typically devoid of vegetation. The absence of vegetation could potentially be due to PWC and other vessel use (NPS 2002c).

VISITOR USE AND EXPERIENCE

Chickasaw National Recreation Area encompasses 9,888.83 acres. Chickasaw is one of the most heavily visited parks for its size in the national park system, with over 3 million total visits and 1.5 million recreation visits a year. The peak season is from Memorial Day to Labor Day, with activities focusing on water recreation and camping. The lowest visitation occurs during January and February.

Generally, visitors to Chickasaw are very satisfied with their experiences. The most recent visitor survey, which was conducted in 2002, had an 88% response rate, and 92% of the respondents indicated overall satisfaction. In 2001, 96% of the respondents were satisfied overall; in 2000, 91%; in 1999, 99%; and in 1998, 93%.

ANNUAL RECREATIONAL VISITOR USE

Annual recreational visitor data from 1979 to 2001 indicate wide variations. Visitation peaked between 1982 and 1985, with 2.0–2.2 million recreation visits. From 1997 to 2001 annual visitation increased 1.2% per year. Based on the data available for the 22-year period, no increase in park visitation is anticipated over the next 10 years (Table 12).

TABLE 12: AVERAGE ANNUAL RECREATION VISITATION AT CHICKASAW, 1979–2001

Year	Number of Recreation Visits	Percentage Change from Previous Year
1979	1,434,484	--
1980	1,927,044	+ 3.4
1981	1,697,658	- 11.9
1982	2,094,319	+ 2.3
1983	2,238,456	+ 6.9
1984	2,026,727	- 9.5
1985	2,129,513	+ 5.1
1986	1,983,835	- 6.8
1987	1,854,417	- 6.5
1988	1,884,537	+ 1.6
1989	1,962,353	+ 4.1
1990	1,600,628	- 18.4
1991	1,453,032	- 9.2
1992	1,385,386	- 4.7
1993	1,370,475	- 1.1
1994	1,446,711	+ 5.6
1995	1,686,136	+ 16.6
1996	1,551,574	- 8.0
1997	1,572,079	+ 1.3
1998	1,615,577	+ 2.8
1999	1,602,065	- 0.8
2000	1,389,537	- 13.3
2001	1,608,792	+ 15.8

SOURCE: NPS 2003.

MONTHLY VISITOR USE

Visitor use data for July 2002 was documented by park staff for specific activities at the three boat launch locations within the national recreation area (Guy Sandy, Buckhorn, and The Point). During July 2002 approximately 1,002 personal watercraft were observed on the reservoir. Table 13 summarizes the July 2002 monthly visitor use for specific activities at the three boat launch locations within the national recreation area.

TABLE 13: MONTHLY VISITOR USE, JULY 2002

Location	Number of Visitors			
	PWC	PWC Users	Boats	Boaters
Guy Sandy	226	452	925	3,700
Buckhorn	464	759	1,387	6,108
The Point	312	620	1,212	4,844
Total	**1,002**	**1,831**	**3,524**	**14,652**

VISITOR ACTIVITIES

Chickasaw remains relatively undeveloped. Summer visitors engage in camping, picnicking, hiking, mountain biking, horseback riding, hunting, sightseeing, auto touring, nature viewing, and photography. Water-oriented activities include boating, waterskiing, fishing, and swimming. Water-related activities include the use of speedboats, personal watercraft, sailboats, sea kayaks, and canoes. PWC use may affect other recreational activities, which are described below.

Camping

The National Park Service operates nine campgrounds at Chickasaw. Camping is restricted to designated campsites. The location and number of campsites provided at each campground are provided below. The campgrounds in **bold text** are located along the shoreline of Lake of the Arbuckles.

- Rock Creek Campground — 105 campsites and 1 group site
- Central Campground — 10 group sites
- Cold Springs Campground — 63 campsites and 2 group sites
- **Buckhorn Campground**

  Loop A — 19 campsites, including 1 handicapped site

  Loop B — 25 campsites, including 1 handicapped site

  Loop C — 41 campsites, including 2 handicapped sites

  Loop D — 49 campsites, including 3 handicapped sites
- **Point Campground —** 55 campsites, including 1 handicapped site
- **Guy Sandy** — 40 campsites

Hiking/Backpacking

There are eight designated, maintained major trails at Chickasaw. Many lesser-used side trails connect the trails and are often used by hikers to vary a route. The park discourages the creation of new shortcut trails, and backcountry hiking is not permitted. The major trails are listed below; those in **bold text** are along the shoreline of Lake of the Arbuckles:

- Antelope and Buffalo Springs Trail — 1.2 miles along Travertine Creek. The Prairie Loop Trail (0.6 miles), Tall Oaks Loop Trail (0.5 miles), and Dry Creek Loop Trail (1.8 miles) are side trails off of the main access trail.
- **Arbuckle District Trails** — Three prominent trails are located along the shores of Lake of the Arbuckles: two trails at The Point arm of the lake (Fishing Rock Trail, 0.8 mile; Lakeview Trail, 0.5 mile), and one trail at the Buckhorn arm (Buckhorn area trail, 0.9 mile).

- Bison Pasture Trail — 1.9 miles along Rock Creek.
- Flower Park — 0.5 mile through the historic district of the park.
- Travertine Creek Trail — 1.5 miles from the Travertine Nature Center along Travertine Creek.
- Veterans Center Trail — 0.5 mile from Pavilion Springs to the perimeter road and to the Oklahoma Veterans Center.
- Veterans Lake Trail — 2.8 miles along the shoreline of Veterans Lake.
- Rock Creek Multi-Use Trail — A network of hiking, biking, and horse-riding trails along the Rock Creek corridor of the park.

Shoreline Use

Roads provide access to certain areas of Lake of the Arbuckles shoreline. No off-road travel is permitted in the national recreation area. The majority of shoreline use is near the boat launch points of The Point, Buckhorn, and Guy Sandy. Picnicking and swimming are normal activities for shoreline visitors. Swimming from boat docks, fishing docks, and boat launching ramps is prohibited on Lake of the Arbuckles and Veterans Lake. Fishing is allowed on Rock Creek, Lake of the Arbuckles, and Veterans Lake. Trotlines, juglines, seining, and dip netting bait for personal use are permitted in Lake of the Arbuckles.

Watercraft Use (Motorboats, Canoes, and Sea Kayaks)

The largest group of motorized watercraft in the national recreation area is motorboats. According to monthly visitor use for July 2002, approximately 3,524 boats were recorded on Lake of the Arbuckles. Most boaters launch from either the Buckhorn, The Point, or the Guy Sandy boat ramp. There is a small ramp at Upper Guy Sandy in the Upper Guy Sandy arm of the lake. Most canoeists (and very few kayakers) prefer tributary creeks to Lake of the Arbuckles and smaller lakes where PWC use is prohibited. Visitors also canoe at the camping areas near The Point and the Buckhorn developed area (M. Foust, NPS, pers. comm., P. Steinholtz, URS, Oct. 10, 2002).

Swimming

Swimmers congregate at the end of Highway 110 (The Point area) and all around the Buckhorn camping, picnic, and pavilion areas. Visitors also swim at the G Road Cliffs, which is in the extreme eastern end of the Buckhorn arm, and the B Road, which is on the eastern end of The Point. In addition, swimmers frequent areas that are closed to PWC use, such as Veterans Lake, Travertine Creek, and Rock Creek (M. Foust, NPS, pers. comm., P. Steinholtz, URS, Oct. 10, 2002).

PWC Use

Based on ranger observations, most PWC users are from the immediate region. Oklahoma City and the Dallas/Fort Worth area are within a radius of about 200 miles; about 5.5 million people live within this area. PWC use occurs primarily from April to September. There are PWC users on the lake year-round, but the majority of users come when the weather is good. Recreationists spend an average of four hours on the lake.

PWC use accounts for 20%–30% of total motorized watercraft annually. However, for 2001 NPS staff estimate that PWC use equaled less than 2% of total Chickasaw visitation. The majority of PWC users come for the day, transporting their own personal watercraft (Law et al. 2002).

Volume of PWC Use. The park began counting personal watercraft in 1996, and through the end of June 2001 approximately 1,820 personal watercraft had been counted in the park (on a cumulative basis), compared to about 7,150 boats (R. Shireman, NPS pers. comm., D. Jones, URS, Aug. 13, 2002). Based on the number of launch ramp permits issued, PWC use declined from 1997 to 2000. Figures for annual launch ramp permits for the recreation area are shown in Table 14.

TABLE 14: ANNUAL BOAT LAUNCH PERMITS

Fiscal Year	Total Annual Permits	Annual Permits Issued to PWC Users	Percentage of PWC to Total Permits
1997–98	928	162	17.5%
1998–99	854	127	14.9%
1999–00	898	125	13.9%
2000–01	882	114	12.9%

SOURCE: NPS 2002b.

In addition to annual permits, day use permits are also issued. These do not specify the type of boat being used; based on staff observations, the percentage of PWC users entering the lake is higher for day use permits during the warm weather season (R. Shireman, NPS pers. comm., D. Jones, URS, Aug. 13, 2002). On busy summer weekends in 2001 and 2002, park staff observed between 34 to 94 personal watercraft per day in the recreation area.

According to park records, approximately 59 personal watercraft per day were observed during the midweek July 4, 2002, holiday period (Wednesday through Friday), and approximately 114 personal watercraft per day were observed on the following Saturday and Sunday (based on Chickasaw daily park logs at three boat launch ramps in July 2002). PWC use within Chickasaw is estimated to increase 1% per year until 2012.

PWC Use Areas. The "Superintendent's Compendium" (see appendix A) has closed all lakes of 100 acres or less to PWC use, which includes Veterans Lake (67 acres). The only lake which PWC use is permitted is Lake of the Arbuckles. In addition, three areas of Lake of the Arbuckles are closed to all vessels to protect swimmers — the Goddard Youth Camp Cove, an area surrounding The Point, and certain areas near Buckhorn. This exclusion rule is sometimes violated in the Buckhorn and The Point when visitors on PWC and boats access picnic sites.

The central part of the main body of Lake of the Arbuckles is a high-use area for personal watercraft. Other high-use areas include in front of The Point and all along the Buckhorn developed area. About 98% of motorcraft operators launch at Buckhorn, The Point, and Guy Sandy. In addition, there is a small ramp at Upper Guy Sandy.

No-wake zones include any area where "No Wake" buoys are located (which include the Upper Guy Sandy, Rock Creek, Buckhorn and Dry Branch lake arms) and within 150 feet of all docks, launch ramps, boats at anchor, boats from which people fish, and shoreline areas near campgrounds. No-wake areas are set aside for fishing, canoeing, float tubing, and sailboating. Violations of the no-wake zone occur in all closed areas, including the Rock Creek area.

VISITOR CONFLICTS AND SAFETY

RELATED FEDERAL AND STATE PWC REGULATIONS

Oklahoma's Boat and Water Rules, Regulations, and Safety Laws (enforced by the Oklahoma Department of Public Safety, Lake Patrol Division) are enforced at the reservoir for all motor vessel use, including PWC use. There are no local ordinances regarding PWC operation that are applicable to the reservoir.

Chickasaw has adopted watercraft regulations for motor vessel use at the park. These regulations apply to all motor vessel use on the reservoir. The regulations relating to PWC use at the reservoir stipulate the following:

- Required safety equipment on board:
    1. Wearable personal flotation devices (PFDs) must be available, in good condition, of proper size, and readily accessible for each passenger on board. Children 12 and under must wear PFDs when underway. Every vessel must carry one type IV throwable device. All PFDs must be USCG approved.
    2. All vessels must carry a USCG approved fire extinguisher in good working order.
    3. All vessels must carry a horn, whistle, or sound producing mechanical device.
    4. All vessels used between sunset and sunrise, must show a red/green light combination facing forward, a white light at the stern when underway, and a white light at the stern when anchored.
- No person shall operate a personal watercraft from sunset to sunrise.
- When towing a skier there must be an observer at least 8 years old, or the vessel must be equipped with an efficient wide-angle convex rearview mirror. Skiing is allowed only between sunrise and sunset.
- All vessels must be equipped with a muffler system, in good working order, which cannot be modified to increase the noise level.
- No person under 12 years of age may solely operate a personal watercraft.
- A vessel may not operate within 150 feet of any person, dock, or an anchored or moored vessel at a speed greater than "idle or slow steerageway speed."
- All vessels must comply with "no wake" and "no boat" designated areas of the lake.
- Operating a vessel within 150 feet of a diver's down flag is prohibited.
- Operating a vessel in excess of the loading or horsepower limits (capacity plate) is prohibited.
- Riding in or on a trailered vessel is prohibited except while actually loading or launching.

The Chickasaw National Recreation Area "Superintendent's Compendium" (36 CFR 1, revised January 2000] includes boating provisions in section 3.6 for speed limits, wake zones, use areas, and prohibited areas.

PWC-RELATED CONFLICTS WITH OTHER VISITORS

Conflicts in visitor use can arise in areas that restrict boats of any kind, such as the end of Highway 110 (near The Point) and along the Buckhorn Pavilion to the F Loop picnic areas along the lake. These areas attract swimmers who may or may not be associated with a boat or personal watercraft, and conflict occurs when these vessels come into the areas to beach, pick up passengers, or change operators.

From 1995 to July 2001 there were 20 vessel accidents in the recreation area, 10 of which involved personal watercraft. Five of the PWC accidents were collisions with boats, three were collisions with other personal watercraft, and two involved PWC operators falling or being thrown off their vessels. Six of the 10 accidents resulted in personal injury, and two only in property damage. Eight of these accidents occurred in the following areas: Buckhorn Arm (4), Guy Sandy Arm (2), Point Arm (1), the central lake area (1); no data is available for the locations of the other two (E. Cummins, NPS, pers. comm., M. Foust, NPS, July 07 and 16, 2001). From July 2001 to August 2002 a total of 7 accidents have been reported: 5 boat-only accidents and 2 PWC-only accidents (S. Staples, NPS, pers. comm., D. Jones, URS, Aug. 26, 2002).

Many activities undertaken by visitors in the nearshore area of Chickasaw are extremely compatible. For example, swimming, picnicking, and beachcombing are all possible along the shoreline and produce little or no conflict between visitors. However, boating near swimmers can pose a safety conflict for both parties. As discussed under "Soundscapes," noise generated by PWC use can also affect visitor experiences.

Conflicts have occurred at the national recreation area between anglers and other boaters. Chickasaw conducted a study several years ago to determine visitor use conflicts between anglers and water-skiers. Although the study does not mention conflicts between anglers and PWC operators, it demonstrates the potential for conflicts between anglers and motorized boat users by noting that "the dissimilar nature of these two activity forms make the goals of the recreationists vulnerable to interference (recreation conflict)" (Parker 1981).

CULTURAL RESOURCES

The area of Chickasaw National Recreation Area has been inhabited by humans for the past 7,000 years. Before European exploration of the New World, ancestors of modern Native American tribes lived in Oklahoma or followed bison migrations across the central and southern plains.

The recreation area is part of the general prehistoric cultural province of the Caddoan-speaking tribes of the central and southern plains. It is internally marginal to the localities of two moderately well-defined cultural entities, the Henrietta focus and the Washita focus, both early village agriculturalist groups. Sites representative of the Spiro focus and the Fulton aspect could also exist in the area. Any Archaic sites that may be present are expected to have Fourche Maline or Grove focus affinities or perhaps the Edwards Plateau material of north-central Texas. There are no known Paleo-Indian sites in the area. The suspected, tentative cultural sequence of the area is as follows:

- Paleo-Indian — Possibly 10,000 B.C. to 5,000–6,000 B.C.
- Archaic — 5,000–6,000 B.C. to early centuries of the Christian era
- Washita and Henrietta — A.D. 1000 to 1450, or slightly later
- Historic Tribes — 1700s to present

The Indian Removal Act of 1830 mandated the removal of Native American tribes from the southeastern United States to Indian Territory in what would become Oklahoma. The Choctaw Nation was the first of these tribes to migrate from Alabama and Tennessee to Indian Territory in 1831, settling on assigned lands south of the Canadian River in southeast Oklahoma. In 1837 the Chickasaw Nation entered Indian Territory, occupying the western part of the Choctaw territory. The Five Civilized Tribes and others established towns, governments, schools, and farms through the 1840s and 1850s. By 1855, the Chickasaw Nation had separated from the Choctaw Nation, occupying land west of Choctaw settlements in an area now containing the national recreation area. Some Chickasaw settled on this land.

HISTORICAL BACKGROUND

Anglos erected the first permanent structure within the park site in 1888, and informal circulation patterns were begun. Anglo settlers built stores, hotels and other businesses around the Seven Springs area (known today as Pavilion Springs) between 1885 and 1896, paying rent to the Chickasaw Nation. This period denotes a vernacular landscape, with trails to the springs and roads developing along the natural paths of commerce and recreation. In 1896 the Dawes Commission platted the town of Sulphur Springs around the settlement site. By the turn of the century, Anglo settlers had built stores, hotels, and other businesses in the Seven Springs area and had attracted 1,198 residents by 1900. Concerned that the springs would not be available for everyone, the Chickasaw and Choctaw ceded 640 acres to the federal government in 1902 to ensure their protection, resulting in the creation of the Sulphur Springs Reservation. Business owners and residents, forced to relocate to land south and west of present headquarters, constructed more than 200 buildings at the new site.

After the Congressional Appropriations Act of April 21, 1904, enlarged the reservation by 218.89 acres, the town relocated to the present-day Sulphur townsite north and south of the reservation. Buildings in the park were removed, while vehicular access and pedestrian trails to the site's springs and other landscape features remained. Sulphur Springs Reservation opened to the public on April 29,1904. The park headquarters were moved that year to the historic J. G. Leeper House built in 1894 and the only modern-day survivor from the 19th century townsite.

In 1906 the site was named Platt National Park in honor of Senator Orville H. Platt of Connecticut. Although the park received little funding during this period, springs were developed; pavilions, causeways, and recreation dams were constructed; and roads were improved. Lincoln Bridge was completed in 1909. Black Sulphur Springs Pavilion was planned in 1929. Also, some residences were constructed within the park during this period. By 1931 the park was attracting up to 320,000 visitors per year.

In May 1933 the Civilian Conservation Corps began major development at the park. Using NPS rustic designs, the CCC constructed roads, bridges, pavilions, restrooms, recreation dams, resident housing, and facilities at the various springs. More than a half million trees were planted, and many structures from the early 1900s were removed. The CCC left the park in January 1940.

Between 1964 and 1967 Arbuckle Dam was constructed to form Lake of the Arbuckles. Arbuckle Recreation Area was created under the administration of the National Park Service, and land along Rock Creek was added to connect the recreation area to Platt National Park. During the National Park Service's Mission '66 era a number of changes were made to CCC-period facilities. In 1976 Arbuckle Recreation Area was renamed Chickasaw National Recreation Area as a fitting memorial to the Chickasaw Nation. The historic park district was renamed the Travertine District, a name it carried until mid-1996 when it was again renamed, becoming the Platt District, in recognition of its 70-year history as Platt National Park.

ARCHEOLOGICAL RESOURCES

Previous archeological inventory work in the vicinity of Chickasaw can be characterized as sporadic and nonsystematic, with such inventories being primarily related to compliance activities. Past archeological surveys at the Arbuckle District have identified at least 53 sites, many of which were inundated when the Arbuckle reservoir was filled. Surface collections made during several surveys suggest that the region has been occupied since the Archaic period.

SUBMERGED CULTURAL RESOURCES

An archeological reconnaissance by the University of Oklahoma in 1958–60 located 19 archeological sites within what was to become the Arbuckle Recreation Area (now essentially the Arbuckle District). A 1964 survey located 34 more sites. Most of these were inundated as the reservoir filled.

ETHNOGRAPHIC RESOURCES

Both the Chickasaw and the Choctaw valued the springs in the area for their curative powers, and many Chickasaw tribal members continue to live in the general vicinity. Guy Sandy Creek is named for Malcom Guy, a former Chickasaw governor, whose allotment was on the creek. No specific traditional cultural properties have been identified to date along Lake of the Arbuckles. Consultation with the affiliated tribes including the Apache Tribe of Oklahoma, Caddo Tribal Council, Chickasaw Nation, Choctaw Nation of Oklahoma, Comanche Tribal Business Committee, Pawnee Business Council, Wichita Executive Committee are ongoing.

Appropriate Native American tribes were contacted and no concerns have been expressed regarding PWC use at Lake of the Arbuckles. An ethnographic study of the Platt District has been initiated and that portion of the national recreation area is a significant ethnographic resource (Wray and Roberts 2001). However, it would appear that the activity areas in the Platt District are far enough from the lake so as not to be influenced by PWC use. A specific survey for ethnographic resources in the Lake of the Arbuckles District has not been undertaken, but no specific concerns about this area have been expressed.

SOCIOECONOMIC ENVIRONMENT

A detailed description of the socioeconomic environment affected by PWC use at Chickasaw is provided in the report "Economic Analysis of Personal Watercraft Regulations in Chickasaw National Recreation Area" (Law et al. 2002).

Chickasaw is in Murray County south of Sulphur, Oklahoma (population 4,794). Nearby cities and towns include Davis (approximately 3 miles, population 2,610) to the northwest, Wynnewood (approximately 20 miles, population 2,367) to the northwest, and Dougherty (approximately 7 miles, population 224) to the south. The nearest large metropolitan areas are Oklahoma City (approximately 90 miles, population 506,132) to the north and Dallas, Texas (approximately 120 miles, population 1,188,580) to the south. Census data for Murray County and Oklahoma City show an average growth rate of 0.89% from 1990 to 2000 (U.S. Bureau of the Census).

As previously mentioned, PWC use accounts for 20%–30% of total motorized watercraft annually. However, for 2001 NPS staff estimate that PWC use equaled less than 2% of total Chickasaw visitation.

The majority of PWC users come for the day, transporting their own personal watercraft (Law et al. 2002).

No businesses that sell, rent, or service personal watercraft were identified near Sulphur; however, three firms generate income from PWC users. Two facilities in Murray County store personal watercraft for local owners, and one shop in the immediate vicinity of Chickasaw sells PWC accessories (Law et al. 2002).

NATIONAL RECREATION AREA MANAGEMENT AND OPERATIONS

Chickasaw currently has six permanent law enforcement staff positions (although usually no more than one ranger patrols at a time) and one seasonal staff position. Rangers concentrate more on land activities because not enough officers are available for full-time boat patrols. Boat patrols on Lake of the Arbuckles are conducted on a regularly scheduled basis for six to eight hours on summer high-use days, such as weekends, or during fishing tournaments (typically Thursday nights). Search-and-rescue patrols are infrequent and occur as needed.

Chickasaw rangers cooperate with the Oklahoma officers, the Murray County Sheriff's Department, the Sulphur Police Department, and the Sulphur Fire Department under the provisions of memorandums of understanding with each for law enforcement assistance.

According to NPS staff, the lack of routine boat patrols limits their effectiveness for enforcing boating regulations and overseeing water-related activities. Based on PWC accidents that have been reported to date, there is the potential for conflicts to occur between visitors who use Lake of the Arbuckles.

ENVIRONMENTAL CONSEQUENCES

SUMMARY OF LAWS AND POLICIES

Three overarching environmental protection laws and policies guide the National Park Service — the National Environmental Policy Act (NEPA) of 1969, and its implementing regulations; the National Parks Omnibus Management Act of 1998; and the NPS Organic Act.

1. The National Environmental Policy Act is implemented through regulations of the Council on Environmental Quality (CEQ) (40 CFR 1500–1508). The National Park Service has in turn adopted procedures to comply with the act and the CEQ regulations, as found in *Director's Order #12: Conservation Planning, Environmental Impact Analysis, and Decision-making* (2001), and its accompanying handbook.

2. The National Parks Omnibus Management Act of 1998 (16 USC 5901 et seq.) underscores the National Environmental Policy Act in that both are fundamental to NPS park management decisions. Both acts provide direction for articulating and connecting the ultimate resource management decision to the analysis of impacts, using appropriate technical and scientific information. Both also recognize that such data may not be readily available, and they provide options for resource impact analysis should this be the case.

   The Omnibus Act directs the National Park Service to obtain scientific and technical information for analysis. The NPS *DO #12 Handbook* states that if "such information cannot be obtained due to excessive cost or technical impossibility, the proposed alternative for decision will be modified to eliminate the action causing the unknown or uncertain impact or other alternatives will be selected" (sec. 4.4).

   Section 4.5 of *DO #12* adds to this guidance by stating "when it is not possible to modify alternatives to eliminate an activity with unknown or uncertain potential impacts, and such information is essential to making a well-reasoned decision, the NPS will follow the provisions of the regulations of CEQ (40 CFR 1502.22)." In summary, the Park Service must state in an environmental assessment or impact statement (1) whether such information is incomplete or unavailable; (2) the relevance of the incomplete or unavailable information to evaluating reasonably foreseeable significant adverse impacts on the human environment; (3) a summary of existing credible scientific adverse impacts that is relevant to evaluating the reasonably foreseeable significant adverse impacts; and (4) an evaluation of such impacts based on theoretical approaches or research methods generally accepted in the scientific community.

3. The 1916 NPS Organic Act (16 USC 1) commits the National Park Service to making informed decisions that perpetuate the conservation and protection of park resources unimpaired for the benefit and enjoyment of future generations.

GENERAL METHODOLOGY FOR ASSESSING IMPACTS

While much has been observed and documented about the overall effects of personal watercraft on the environment, as well as public safety concerns, site-specific impacts under all conditions and scenarios are difficult to measure and affirm with absolute confidence. Since personal watercraft were introduced in parks, data collected and interpreted about them and their effects on park resources relative to other uses and influences are difficult to define and quantitatively measure, despite monitoring.

Recognizing this dilemma, the interdisciplinary planning team created a process for impact assessment, based upon the directives of the *DO #12 Handbook* (sec. 4.5(g)). NPS planning teams are directed to assess the extent of impacts on park resources as defined by the context, duration, and intensity of the effect. While measurement by quantitative means is useful, it is even more crucial for the public and decision-makers to understand the implications of those impacts in the short and long term, cumulatively, and within context, based on an understanding and interpretation by resource professionals and specialists.

Potential impacts are described in terms of type (Are the effects beneficial or adverse?), context (Are the effects site-specific, local, or even regional?), duration (Are the effects short-term, lasting less than one year, or long-term, lasting more than one year?), and intensity (Are the effects negligible, minor, moderate, or major?). Because definitions of intensity (negligible, minor, moderate, or major) vary by impact topic, intensity definitions are provided separately for each impact topic analyzed in this document.

To determine impacts, methodologies were identified to measure the change in park resources that would occur with the implementation of the PWC management alternatives. Thresholds were established for each impact topic to help understand the severity and magnitude of changes in resource conditions, both adverse and beneficial, of the various management alternatives. In the absence of quantitative data, best professional judgment was used to determine impacts. In general, the thresholds used come from existing literature on personal watercraft, federal and state standards, and consultation with subject matter experts and appropriate agencies.

Each alternative is compared to a baseline to determine the context, duration, and intensity of resource impacts. For purposes of impact analysis, the baseline is the continuation of PWC use over the next 10 years (alternative A).

In addition to establishing impact thresholds, the national recreation area's resource management objectives and goals (as stated in the "Purpose of and Need for Action" chapter) were integrated into the impact analysis. In order to further define resource protection goals relative to PWC management, the park's *Strategic Plan* was used to ascertain the "desired future condition" of resources over the long term. The impact analysis then considers whether each management alternative contributes substantially to the park's achievement of its resource goals, or would be an obstacle. The planning team then considered potential ways to mitigate effects of personal watercraft on park resources, and the alternatives were modified accordingly.

For the purposes of analysis, the following assumptions are used for all impact topics (in this document the terms "impact" and "effect" are used interchangeably):

Short-term impacts: Those impacts occurring from PWC use in the immediate future (per trip through a single season of use, usually 1 to 6 months).

Long-term impacts: Those impacts occurring from PWC use over several seasons of use through the next 10 years.

Direct impacts: Those impacts occurring from the direct use or influence of PWC use.

Indirect impacts: Those impacts occurring from PWC use that indirectly alter a resource or condition.

Impact Analysis Area: Each resource impact is assessed in direct relationship to those resources affected both inside and outside the park, to the extent that the impacts can be substantially traced, linked, or connected to PWC use inside park boundaries. Each impact topic, therefore, has

an impact analysis area relative to the resource being assessed, and it is further defined in the impact methodology.

CUMULATIVE IMPACTS

The CEQ regulations to implement the National Environmental Policy Act require the assessment of cumulative impacts in the decision-making process for federal projects. Cumulative impacts are defined as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions" (40 CFR 1508.7). Cumulative impacts are considered for all alternatives, including the no-action alternative.

Cumulative impacts were determined by combining the impacts of the alternative being considered with other past, present, and reasonably foreseeable future actions. Therefore, it was necessary to identify other ongoing or reasonably foreseeable future projects at Chickasaw and, if applicable, the surrounding region. Plans evaluated as a part of the cumulative impact analysis include the following:

- *General Management Plan* (July 1979)
- *Draft Amendment to General Management Plan / Development Concept Plan Environmental Assessment* and "Finding of No Significant Impact" (October 31, 1994)
- *Resource Management Plan, Chickasaw National Recreation Area* (revised September 1988)

The following actions have also been considered in the impact analysis:

- The Chickasaw Nation has proposed a new development in Davis, Oklahoma, which would include a casino, lodge, and convention facility.
- The National Park Service and the Chickasaw Nation have proposed to develop a cultural center at Chickasaw National Recreation Area and the access road to The Point.
- The National Park Service has proposed the development of a new visitor center in 2003.
- A private interest has proposed the sale of water in the Arbuckle Simpson Aquifer to communities in Canadian County. The proposed project could affect water quantity and quality in Lake of the Arbuckles.

IMPAIRMENT ANALYSIS

The NPS *Management Policies 2001* require an analysis of potential effects to determine whether or not actions would impair park resources or values. The fundamental purpose of the national park system, as established by the Organic Act and reaffirmed by the General Authorities Act in 1970, as amended, begins with a mandate to conserve park resources and values. NPS managers must always seek ways to avoid, or to minimize to the greatest degree practicable, adversely impacting park resources and values. However, the laws do give the National Park Service the management discretion to allow impacts to park resources and values when necessary and appropriate to fulfill the purposes of a park, as long as the impact does not constitute an impairment of the affected resources and values. Although Congress has given the National Park Service the management discretion to allow certain impacts within a park system unit, that discretion is limited by the statutory requirement that the agency must leave park resources and values unimpaired, unless a particular law directly and specifically provides otherwise. The prohibited impairment is an impact that, in the professional judgment of the responsible NPS manager, would harm the integrity of park resources or values. An impact to any park resource or value may constitute an

impairment, but an impact would be more likely to constitute an impairment to the extent that it has a major or severe adverse effect upon a resource or value whose conservation is:

- necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the park;
- key to the natural or cultural integrity of the park; or
- identified as a goal in the park's general management plan or other relevant NPS planning documents.

Impairment may result from NPS activities in managing the park, visitor activities, or activities undertaken by concessioners, contractors, and others operating in the park.

The following process was used to determine whether the various PWC management alternatives had the potential to impair park resources and values:

1. The park's enabling legislation, the *General Management Plan,* the *Strategic Plan,* and other relevant background were reviewed with regard to the unit's purpose and significance, resource values, and resource management goals or desired future conditions.
2. PWC management objectives specific to resource protection goals at the park were identified.
3. Thresholds were established for each resource of concern to determine the context, intensity and duration of impacts, as defined above.
4. An analysis was conducted to determine if the magnitude of impact reached the level of "impairment," as defined by NPS *Management Policies*.

The impact analysis includes any findings of impairment to park resources and values for each of the management alternatives.

PWC USE TRENDS

PWC use trends were identified to determine direct and indirect impacts of various management strategies on reservoir resources. The trends were based on Chickasaw recreational visitation data, NPS staff observations and estimates, and Oklahoma boat registration trends. Oklahoma pleasure boat registration data for the last six years shows an average growth rate of 2%, as shown in Table 15. National PWC registration trends show a 3.9% decline, from 1,096,000 in 1999 to 1,053,560 in 2001 (see Table 1). Based on this information, PWC and motorboat numbers are assumed to increase by 1.0% annually for the next 10 years at Chickasaw. Park visitation, which has remained relatively constant since 1991, is not expected to change over the next 10 years.

TABLE 15: OKLAHOMA BOAT REGISTRATION STATISTICS, 1996–2001

Year	Boats Registered	Percentage Change
1996	206,000	
1997	223,267	+8.4%
1998	225,021	<+0.1
1999	225,242	<+0.1%
2000	229,890	+2.1%
2001	221,464	-3.7%
Average		+1.25%

SOURCE: Oklahoma Division of Public Safety, pers. comm., R. Wieland, URS, Sept. 19, 2002.

* In Oklahoma, registrations are provided for the general class of boats. Boats are not defined by type, size, or class.

Chickasaw launching ramp data sheets for launching ramps at Guy Sandy, The Point, and Buckhorn provided data for PWC daily use for the month of July 2002. On a busy summer weekend in 2001 and 2002, an average of 66 PWC per day were observed on the reservoir. Therefore, by 2012, PWC use is projected to increase to approximately 73 craft per day. The highest total numbers of personal watercraft were counted on a holiday weekend in 2002, with a reported 135 personal watercraft. On an annual basis, there were an estimated 8,294 personal watercraft in 2002, which would increase to 9,162 by 2012 (assuming a 1% annual increase). Total outboard motorboat use at Chickasaw in 2002 was estimated to be 21,865 boats, which would increase to 24,154 by 2012, with a 1% annual increase.

WATER QUALITY

Most research on the effects of personal watercraft on water quality focuses on the impacts of two-stroke engines, and it is assumed that any impacts caused by these engines also apply to the personal watercraft powered by them. There is general agreement that two-stroke engines (and personal watercraft) discharge a gas-oil mixture into the water. Fuel used in PWC engines contains many hydrocarbons, including benzene, toluene, ethylbenzene, and xylene (collectively referred to as BTEX). Polycyclic aromatic hydrocarbons (PAHs) also are released from boat engines, including those in personal watercraft. These compounds are not found appreciably in the unburned fuel mixture, but rather are products of combustion. Discharges of all these compounds — BTEX and PAHs — have potential adverse effects on water quality. Some research shows that PAHs, including those from PWC emissions, adversely affect water quality by means of harmful phototoxic effects on ecologically sensitive plankton and other small water organisms (US EPA 1998; Oris et al. 1998; Landrum et al. 1987; Mekenyan et al. 1994; Arfsten et al. 1996). This in turn can affect aquatic life and ultimately aquatic food chains. The primary concern is in shallow water ecosystems. A common gasoline additive, methyl tertiary butyl ether (MTBE) is not used in gasoline sold in Oklahoma (S. Jolly, Arbuckle Master Conservancy District, pers. comm., T. Campbell, URS, Sept. 23, 2002).

A typical conventional (i.e., carbureted) two-stroke PWC engine discharges as much as 30% of the fuel directly into the water (NPS 1999; CARB 1999). At common fuel consumption rates, an average two-hour ride on a personal watercraft may discharge 3 gallons of fuel into the water (NPS 1999). According to data from *Personal Watercraft Illustrated* and US EPA (Bluewater Network 2001), an average 2000 model-year personal watercraft can discharge between 3.8 and 4.5 gallons of fuel during one hour at full throttle. (As described in appendix B, an estimated discharge rate of 3 gallons per hour is used in the water quality impact calculations.)

As described below, hydrocarbon (HC) discharges to water are expected to decrease significantly over the next 10 years due to mandated improvements in engine technology (US EPA 1996a, 1997).

GUIDING REGULATIONS AND POLICIES

The U.S. Environmental Protection Agency has developed national recommended ambient water quality criteria for approximately 120 priority pollutants for the protection of both aquatic life and human health (through ingestion of fish/shellfish or water) (US EPA 1999a). These criteria have been adopted as enforceable standards by most states. The Environmental Protection Agency has not established any criteria for the protection of aquatic life for any of the PWC-related compounds stated above. For the human health criteria, however, the Environmental Protection Agency has established criteria for benzene, ethylbenzene, toluene, and several PAH compounds. There are no criteria for xylene.

The NPS *Management Policies 2001* state that the Park Service will "take all necessary actions to maintain or restore the quality of surface waters and ground waters within the parks consistent with the Clean Water Act and all other applicable federal, state, and local laws and regulations" (sec. 4.6.3).

Chickasaw does not have quantitative water quality data documenting the effects of PWC use since they were introduced in the 1970s. To address water quality impacts potentially resulting from continued PWC use, water quality benchmarks were used in the absence of unit-specific data as a basic principle to guide the analysis.

Simply stated, a water quality standard defines the water quality goals of a waterbody by designating uses to be made of the water, by setting minimum criteria to protect the uses, and by preventing degradation of water quality through antidegradation provisions. The antidegradation policy is only one portion of a water quality standard. Part of this policy (40 CFR 131.12(a)(2)) strives to maintain water quality at existing levels if it is already better than the minimum criteria. Antidegradation should not be interpreted to mean that "no degradation" can or will occur, as even in the most pristine waters, degradation may be allowed for certain pollutants as long as it is temporary and short term (Rosenlieb, NPS, WRD, pers. comm., Tom Campbell, URS, 2001).

Other considerations in assessing the magnitude of water quality impacts is the effect on those resources dependent on a certain quality or condition of water. Sensitive aquatic organisms, submerged aquatic vegetation, riparian areas, and wetlands are affected by changes in water quality from direct and indirect sources.

While many parks do have established water quality monitoring programs, the specific organic compounds emitted from personal watercraft are not systematically measured. In the absence of park-specific data, available water quality benchmarks or criteria and estimated discharge rates of organics were used as the basic tools to address water quality impacts potentially resulting from PWC use.

METHODOLOGY AND ASSUMPTIONS

In order to assess the magnitude of water quality impacts to park waters under the various PWC management alternatives, the following methods and assumptions were used:

1. The regulation at 40 CFR 131.12(a)(2) represents an overall goal or principle with regard to PWC use in that the park will strive to fully protect existing water quality so that "fishable / swimmable" uses and other existing or designated uses are maintained. Therefore, PWC use could not be authorized to the degree that it would lower this standard and affect these uses. To do so would potentially violate 40 CFR 131.10, which basically forbids the removal of an existing use (e.g., personal watercraft) because the activity was authorized knowing this level of pollution would occur.
2. State water quality standards governing the waters of the park were examined for pollutants whose concentrations in gasoline were available in the literature and for which ecological and/or human health toxicity benchmarks were available in the literature.
3. Baseline water quality data (if available), especially for pollutants associated with two-stroke engines (PAHs, hydrocarbons), were examined. In Oklahoma, MTBE is not used in gasoline; therefore, it was not included in the analysis. PWC and other motorboats from other states utilizing MTBE as an additive may discharge MTBE to the reservoir. However, because Texas also does not use MTBE in its gasoline and because of the small numbers of out-of-state boats involved, MTBE was not considered in the calculations of water quality impacts.

4. Since no models were available to predict concentrations in water of selected pollutants emitted by personal watercraft and motorboats, an approach was developed to provide estimates of whether PWC (and outboard motor) use over a particular time (for example, over a typical busy weekend day) would result in exceedances of the identified standards, criteria, or toxicity benchmarks. The approach is described in appendix B. Results of this approach were then taken into account, along with site-specific information about currents, mixing, wind, turbidity, etc., as well as the specific fate and transport characteristics of the pollutant involved (e.g., volatility), to assess the potential for the occurrence of adverse water quality impacts.

5. In general, the approach provides the information needed to calculate emissions to the receiving waterbody from personal watercraft (and, by estimation, from outboard motors) of selected hydrocarbons whose concentrations in the raw gasoline fuel were available in the literature and for which ecological and/or human health toxicity benchmarks could be acquired from the literature. The selected chemicals were benzene and three PAHs (benzo(a) pyrene, naphthalene, and 1-methyl naphthalene). The approach outlined a procedure to first estimate the emissions of these pollutants to the water per operational hour (based on literature values) and to then estimate the total loading of the pollutants into the water, based on the estimated hours of use. The approach then provided an estimate of how much water would be required to dilute the calculated emission loading to the level of the water quality standard or benchmark. That volume of water (referred to as the "threshold volume of water") was then compared to the total available volume of water.

   "Oklahoma's Water Quality Standards" include aquatic life and human health standards for benzene only (OWRB 2002). As stated in Table 6 on page 49, water quality standards for benzene are 2,200 µg/L for fish and wildlife propagation (chronic), 12 µg/L for the ingestion of water and fish, and 714 µg/L for the ingestion of fish only.

   Water in Lake of the Arbuckles is used for drinking water; therefore, the Oklahoma standards for fish and wildlife propagation and for ingestion of water and fish were compared with the respective U.S. EPA standards and other benchmarks, and the lower set of standards was used. (By complying with the lower benchmarks, both state and federal criteria are satisfied.) Table 16 shows the criteria and benchmarks used to assess impacts. For benzene, the EPA human health benchmark of 1.2 µg/L was selected; the state standard is less restrictive (12 µg/L).

TABLE 16: ECOTOXICOLOGICAL AND HUMAN HEALTH BENCHMARKS FOR ORGANIC POLLUTANTS

Chemical	Ecotoxicological Benchmark (µg/L)	Source	Human Health Benchmark** (µg/L)	Source
Benzo(a)pyrene	0.014	Suter and Tsao 1996	0.0044	US EPA 1999a
Naphthalene	62	Suter and Tsao 1996	--	--
1-methyl naphthalene	34*	USFWS 1987	--	--
Benzene	130	Suter and Tsao 1996	1.2	US EPA 1999a

* Based on LC_{50} of 3400 µg/L for sheepshead minnow (34 µg/L used for freshwater calculations).

** Based on the consumption of water and fish.

6. The principal mechanisms that result in loss of pollutants from the water also were considered. Many organic pollutants that are initially dissolved in the water volatilize to the atmosphere, especially if they have high vapor pressures, are lighter than water, and mixing occurs at the air/water interface. Other compounds that have low vapor pressure, low solubility, and high octanol/water partition coefficients tend to adhere to organic material and clays and eventually adsorb onto sediments. By considering movements of the organics through the water column, an

assessment can be made as to whether there could be an issue with standards or benchmarks being exceeded, even on a short-term basis.

7. The threshold volume of water was calculated in acre-feet (1 acre-foot [ac-ft] = 1 acre of water 1 foot deep). For example, if results showed that for benzo(a)pyrene, 55 acre-feet of water would be needed to dilute the expected emissions to below the benchmark level, and the receiving body of water is a 100-acre reservoir with an average depth of 20 feet (= 2000 acre-feet) and is well-mixed, then this would indicate little chance of a problem, especially when adding the effects of any other processes that contribute to the loss of benzo(a)pyrene from the water column. However, if the impact area is a 5-acre backwater averaging 2 feet deep (10 acre-feet), then there may be at least a short-term issue, especially if outboard emissions are added or there is little mixing in the area.
8. To assess cumulative impacts, outboard emissions also were determined, based on estimates of relative emissions of unburned fuel and hours of use. Motorboat emissions were then added to PWC emissions to yield a more complete estimation of loading to the receiving waterbody. Inboards contribute very little to the loading and were not included in the estimation. The estimates used for relative loading from various outboard engines are obtained from available data.
9. Reductions in emissions from personal watercraft and outboards are outlined by the U.S. Environmental Protection Agency over the next 16 years (see Table 17).

TABLE 17: ESTIMATED EPA REDUCTIONS IN WATERCRAFT EMISSIONS

Date	Action
1999	EPA requires production line testing for 75% HC reduction in new outboards and begins to see reductions as newer models are introduced (US EPA 1997).
2000	EPA requires production line testing for 75% HC reduction in new personal watercraft and begins to see reductions as newer models are introduced (US EPA 1997).
2006	EPA fully implements 75% HC reduction in new outboards and personal watercraft (US EPA 1996a).
2010	EPA estimates a 52% reduction in overall HC emissions from outboards and personal watercraft (US EPA 1996a)
2012	Approximately a 50% reduction in HC emissions estimated for this analysis based on dates in US EPA (1996a, 1997)
2015	EPA estimates a 68% reduction in overall HC emissions from outboards and personal watercraft (US EPA 1996a)

Key dates in this chronology begin with 1999, when the U.S. Environmental Protection Agency began to require production line testing for 75% HC reduction in new outboard motors, and 2000, when production line testing for 75% HC reduction in new personal watercraft was required (US EPA 1997). These dates represent a delay in testing implementation that was originally scheduled (US EPA 1996a) for 1998 for both personal watercraft and outboard motors. By 2006 all new personal watercraft and outboards manufactured in the United States must have an average 75% reduction in HC emissions (US EPA 1996a). For the purpose of estimating water quality impacts in this assessment, overall reductions in HC emissions are conservatively estimated to be 50% in personal watercraft and outboard motors in 2012. This estimate is based on interpolations of the emissions reduction percentages and associated years (2010 and 2015) reported by the U.S. Environmental Protection Agency in 1996 (US EPA 1996a), but with a one-year delay in production line testing (US EPA 1997).

10. To evaluate water quality impacts at Chickasaw, water volumes and water quality calculations were analyzed for each of two or three areas, depending on the alternative being evaluated. These are:

- the main body of Lake of the Arbuckles — area 1
- all portions of Lake of the Arbuckles where no-wake speeds are required (e.g., reservoir arms near Upper Guy Sandy, Rock Creek, and the Buckhorn area) — area 2 (alternatives B and C)
- areas in Upper Guy Sandy and Rock Creek where PWC use would be prohibited — area 3 (alternative C only)

These groupings were determined to be the most useful in the analysis of water quality impacts because of their identification in the alternatives and the higher relative levels of PWC and motorboat use. The water volume in each area was determined from data contained in USGS quad sheets of the area and estimates of depths provided by park staff (S. Burrough, NPS, pers. comm., T. Campbell, URS, Sept. 24. 2002). Estimated volumes of each area are shown in Table 18.

TABLE 18: ESTIMATED WATER VOLUMES (ACRE-FEET)

Area	Estimated Area (acres)	Estimated Average Depth (ft)	Estimated Volume (ac-ft)
Lake of the Arbuckles (total) — area 1*	2,350	31	72,400
No-Wake Zones (Upper Guy Sandy, Rock Creek, and Buckhorn Creek portions of Lake of the Arbuckles) — area 2, alternative A	500	12	6,000
No-Wake Zones (Upper Guy Sandy, Rock Creek, and Buckhorn developed area of Lake of the Arbuckles) — area 2, alternative B	520	12	6,240
No-Wake Zone (Buckhorn Creek portion of Lake of the Arbuckles) — area 2, alternative C	275	15	4,125
PWC Prohibited Use Zone (Upper Guy Sandy and Rock Creek portions of Lake of the Arbuckles) — area 3, alternative C	360	10	3,600

NOTE: Area is based on a conservation pool elevation of 872 feet.

* Area 1 in the analyses is generally Lake of the Arbuckles; however, the estimated volume varies by alternative because no-wake zones or no PWC-use areas are subtracted; see Table 19.

The volumes presented in Table 18 do not consider the effective mixing volume available during the summer when a thermocline can become established in Lake of the Arbuckles. A thermocline is described as a sharp decrease in water temperature with depth that increases water density and restricts downward mixing of the water column. The depth and strength of the thermocline would vary with year and time of year, typically becoming established in the spring and continuing through the early fall. Although only one set of depth profile data is available, the existence of a thermocline in May 2000 was confirmed by the National Park Service (P. Koenig, NPS, pers. comm., T. Campbell, URS, Sept. 30, 2002). For the purpose of estimating available volumes of water in Lake of the Arbuckles it is assumed that the full volume of the lake is available for mixing/diluting the PWC and motorboat emissions. However, because the full volume of the lake may not be representative of the mixing volume, the potential for a thermocline in the summer is qualitatively discussed in the impact assessment. It is assumed that the no-wake zones do not have themoclines because of their shallow depths.

11. PWC and motorboat numbers and location of operation are provided in the "PWC Use Trends" section. For the assessment of impacts to water quality, the highest numbers of personal watercraft and other motorboats counted during a single day in July 2002 were determined from the Chickasaw launching ramp data sheets for the Guy Sandy, The Point, and Buckhorn launch ramps. The July 2002 data were the only daily counts available for Chickasaw. The highest total

number of personal watercraft and boats was on July 6, 2002: 135 personal watercraft and 335 other boats. Other weekend days in July 2002 had from 34 to 92 personal watercraft and 121 to 255 other motorboats at the three launching ramps. Based on survey information provided by park staff (S. Staples, NPS, pers. comm., R. Wieland, URS, Sept. 4, 2002), less than 1% of the outboard motorboats using Lake of the Arbuckles have motors smaller than 15 horsepower. The numbers of personal watercraft and boats were assumed to increase by 1.0% per year. In 2012, an estimated 148 personal watercraft and 370 motorboats are expected to use Lake of the Arbuckles on a high-use day. Personal watercraft and motorboats would be distributed throughout the national recreation area under each alternative as shown in Table 19.

TABLE 19: PEAK-DAY MOTORIZED WATERCRAFT USE, CHICKASAW NATIONAL RECREATION AREA, 2002 – 2012

	Personal Watercraft		Motorboats	
	2002	2012	2002	2012
Alternative A				
• Lake of the Arbuckles — Area 1 (66,400 ac-ft)	80	88	275	304
• No-Wake Zones — Area 2 (6,000 ac-ft)	55	60	60	66
Subtotal	135	148	335	370
Alternative B				
• Lake of the Arbuckles — Area 1 (66,160 ac-ft)	80	88	275	304
• No-Wake Zones — Area 2 (6,240 ac-ft)	55	60	60	66
Subtotal	135	148	335	370
Alternative C				
• Lake of the Arbuckles — Area 1 (64,675 ac-ft)	110	120	275	304
• No-Wake Zones — Area 2 (4,125 ac-ft)	25	28	20	22
• No PWC Use Zone — Area 3 (3,600 ac-ft)	0	0	40	44
Subtotal	135	148	335	370
No-Action Alternative				
• Lake of the Arbuckles — Area 1 (66,400 ac-ft)	0	0	275	304
• No-Wake Zones — Area 2 (6,000 ac-ft)	0	0	60	66
Subtotal	0	0	335	370

NOTE: An average increase of 1.0% per year is assumed for personal watercraft and other motorboats, based on current use trends.

12. The following describes how PWC and motorboat operations were evaluated to determine potential water quality impacts at Chickasaw:

    - Personal watercraft are launched from three launching ramps at Chickasaw: Guy Sandy, The Point, and Buckhorn. Three areas of Lake of the Arbuckles are described as having a relatively high level of PWC use: Rock Creek, Buckhorn Creek area, and Guy Sandy (up to the golf course) (S. Burrough, NPS, pers. comm., T. Campbell, URS, Sept. 24, 2002).
    - The majority of other motorboats operating within Chickasaw are assumed to have two-stroke outboard engines. All motorboats are assumed to have engines larger than 15 horsepower, and inboard and stern-drive motorboats are not included in the analysis.
    - For a conservative assessment of available volume of water, no lateral mixing of water across the boundaries between areas was assumed. In actuality, water and PWC emissions in each area will mix with adjacent waters to some unknown extent, thus reducing the concentrations

of PWC emissions within each area. By assuming no mixing across the jurisdictional boundaries, the estimated impacts for each alternative are conservative (that is, more than what would likely occur in actuality).

- Boating activity, and therefore pollutant loads, would be distributed over an entire day from early morning to dusk, although for the purpose of calculating impacts, it is assumed that PWC and other motorboats operate for four hours a day. When released to water, benzene is subject to rapid volatilization, with a half-life for evaporation of about 5 hours (US EPA 2001). The loss of benzene from the water column is discussed qualitatively where applicable.
- Some research indicates that PAHs have phototoxic effects in oligotrophic lakes that have high light penetration (Oris et al. 1998). Limited data indicate that in these conditions, PAHs may have phototoxic effects on fish and zooplankton at very low concentrations (less than 1 µg/L). These toxic effects are discussed qualitatively where applicable.
- Human health criteria for the consumption of water and aquatic organisms are included in this analysis because Lake of the Arbuckles is the primary source of municipal water for three municipalities: Ardmore, Davis, and Wynnewood. Sulphur has rights to draw water from Lake of the Arbuckles but does not exercise that right at this time. Their primary source of municipal water is from wells. The human health criteria for benzo(a)pyrene (0.0044 µg/L) and benzene (1.2 µg/L) are used to assess impacts from PWC use. These criteria were selected for use to be protective of people ingesting water and aquatic organisms.

IMPACT ANALYSIS AREA

The impact analysis area for water quality includes Lake of the Arbuckles within the jurisdictional boundary of Chickasaw, Oklahoma.

IMPACT TO WATER QUALITY FROM PWC USE

Given the above water quality issues and methodology and assumptions, the following impact thresholds were established in order to describe the relative changes in water quality (both overall, localized, short and long term, cumulatively, adverse and beneficial) under the various personal watercraft management alternatives.

Negligible: Impacts are chemical, physical, or biological effects that would not be detectable, would be well below water quality standards or criteria, and would be within historical or desired water quality conditions.

Minor: Impacts (chemical, physical, or biological effects) would be detectable but would be well below water quality standards or criteria and within historical or desired water quality conditions.

Moderate: Impacts (chemical, physical, or biological effects) would be detectable but would be at or below water quality standards or criteria; however, historical baseline or desired water quality conditions would be altered on a short-term basis.

Major: Impacts (chemical, physical, or biological effects) would be detectable and would be frequently altered from the historical baseline or desired water quality conditions; and/or chemical, physical, or biological water quality standards or criteria would be slightly and singularly exceeded on a short-term basis.

Impairment: Impacts are chemical, physical, or biological effects that would be detectable and that would be substantially and frequently altered from the historical baseline or desired water quality conditions and/or water quality standards, or criteria would be exceeded several times on a short-term and temporary basis. In addition, these adverse, major impacts to park resources and values would

contribute to deterioration of the park's water quality and aquatic resources to the extent that the park's purpose could not be fulfilled as established in its enabling legislation;

affect resources key to the park's natural or cultural integrity or opportunities for enjoyment; or

affect the resource whose conservation is identified as a goal in the park's general management plan or other park planning documents.

Impacts of Alternative A — Continue PWC Use under a Special Regulation

Analysis. The number of personal watercraft using the lake during a high-use day would increase from 135 per day in 2002 to 148 per day in 2012, an average increase of 1.0% per year. Use would be distributed as shown in Table 19. It is assumed that the personal watercraft in the no-wake zones (area 2) would discharge gasoline and its constituents at one quarter the rate expected at full throttle in the open-water portion of the lake (NALMS 2002). It is assumed that by 2012 emissions would be reduced by 50%, in accordance with the U.S. EPA estimates (1997). Threshold volumes needed to dilute PWC emissions are shown in Table 20.

TABLE 20: THRESHOLD WATER VOLUMES NEEDED TO DILUTE PWC EMISSIONS, ALTERNATIVE A

	Lake of the Arbuckles (minus no-wake zones) — Area 1)		No-Wake Zones (Upper Guy Sandy, Rock Creek, and Buckhorn Creek areas of Lake of the Arbuckles) — Area 2	
	2002	2012	2002	2012
NPS waters open to PWC use (ac-ft):	66,400		6,000	
Ecotoxicological Benchmarks*				
Benzo(a)pyrene (fuel and exhaust)	440	240	76	42
Naphthalene	180	96	30	16
1-methyl naphthalene	500	270	86	47
Benzene	420	230	72	39
Human Health Benchmarks**				
Benzo(a)pyrene (fuel and exhaust)	1,400	770	240	130
Benzene	45,000	25,000	7,800	4,300

* Threshold volumes (ac-ft) below which ecotoxicological effects might occur.

** Threshold volumes (ac-ft) below which human health might be impacted.

The 2002 and 2012 threshold volumes to meet ecotoxicological benchmarks would range from 16 to 500 acre-feet. These volumes are extremely small in relation to the volumes of water available (66,400 ac-ft in Lake of the Arbuckles and 6,000 ac-ft in no-wake zones), indicating that these pollutant loads would result in concentrations well below the ecotoxicological benchmarks. Consequently, negligible adverse impacts are expected in both areas in 2002 and in 2012.

For human health benchmarks, threshold volumes in 2002 and 2012 for benzo(a)pyrene would range from 240 to 1,400 acre-feet in 2002, to 130 to 770 acre-feet, resulting in negligible impacts. The threshold volume for benzene in area 1 in 2002 would be 45,000 acre-feet, resulting in a minor impact. The thresh-

old volume in area 2 would be 7,800 acre-feet, which would result in a moderate adverse impact because impacts would temporarily exceed the human health criteria for the ingestion of water and fish. In 2012 threshold volumes for benzene would range from 25,000 acre-feet in area 1 to 4,300 acre-feet in area 2, resulting in minor impacts in both areas. For benzene, factors other than those discussed above would affect surface water concentrations, especially volatilization. The half-life of benzene in water is less than five hours at summer water temperatures near 30°C (Verschuren 1983; US EPA 2001). In other words, half the benzene in water would evaporate in five hours, reducing it to below the human health criterion. Impacts from benzene in Lake of the Arbuckles could be greater if a strong thermocline became established, which would effectively limit the volume of water available for mixing and dilution.

Cumulative Impacts. In addition to personal watercraft that use Lake of the Arbuckles, other two-stroke outboard motorboats would contribute pollutants to the water. Numbers of motorboats using the lake during a high-use day (in addition to personal watercraft) would increase from 335 per day in 2002 to 370 per day in 2012, an average increase of 1% per year; see Table 19 for the assumed distribution. As described under the assumptions, PWC and motorboat emission rates in 2012 would be 50% of the 2002 rates. Threshold volumes needed to dilute all motorized boat emissions are shown in Table 21.

TABLE 21: THRESHOLD WATER VOLUMES NEEDED TO DILUTE PWC AND MOTORIZED BOAT EMISSIONS, ALTERNATIVE A

	Lake of the Arbuckles (minus no-wake zones) — Area 1		No-Wake Zones (Upper Guy Sandy, Rock Creek, and Buckhorn Creek areas of Lake of the Arbuckles) — Area 2	
	2002	2012	2002	2012
NPS waters open to motorboat use (ac-ft):	66,400		6,000	
Ecotoxicological Benchmarks*				
Benzo(a)pyrene (fuel and exhaust)	2,000	1,100	160	87
Naphthalene	780	430	63	34
1-methyl naphthalene	2,200	1,200	180	98
Benzene	1,900	1,000	150	82
Human Health Benchmarks**				
Benzo(a)pyrene (fuel and exhaust)	6,300	3,500	510	280
Benzene	200,000	110,000	16,000	8,900

* Threshold volumes (ac-ft) below which ecotoxicological effects might occur.

** Threshold volumes (ac-ft) below which human health might be impacted.

The calculated threshold volumes for pollutants emitted in 2002 by personal watercraft and other motorboats would be substantially greater than the threshold volumes due to PWC use alone. The cumulative threshold volumes based on ecotoxicological benchmarks would range from 63 to 2,200 acre-feet (see Table 21). In 2012, ecotoxicological threshold volumes would decrease to a range of 34 to 1,200 acre-feet, despite an increase in the numbers of personal watercraft and other motorboats. Concentrations of all the organic contaminants evaluated would be well below the water quality benchmarks and would likely not be detectable. Cumulative ecological impacts would be negligible in both 2002 and 2012.

Based on human health benchmarks, the calculated threshold volumes for benzo(a)pyrene emitted by personal watercraft and boats would range from 510 to 6,300 acre-feet in 2002 to 280 to 3,500 acre-feet in 2012. All of the benzo(a)pyrene threshold volumes would be substantially lower than the available water volumes in the two areas, therefore resulting in negligible impacts to human health.

The threshold volumes for benzene on a high-use day in 2002 would be 200,000 acre-feet in area 1 and 16,000 acre-feet in area 2, both of which would be substantially higher than the available water volumes (66,400 and 6,000 acre-feet, respectively). Based on a five-hour half-life for benzene, it could take up to 10 hours for the concentrations to be reduced below the human health benchmark. Consequently, benzene impacts to human health in both areas could be potentially major in 2002 following a high-use day.

Impacts in Lake of the Arbuckles due to benzene could be even greater if a strong thermocline became established, thereby effectively limiting the volume of water available for mixing and dilution. Impacts would be less in the no-wake zone when mixing with adjacent waters and flushing by stream inflows are considered. Also, it should be noted that the threshold volumes for benzene based on human health benchmarks would be an order of magnitude lower if the less stringent Oklahoma standard of 12 µg/l (OWRB 2002) was used instead of the EPA standard, which is much more conservative. Monitoring of water quality for benzene in Lake of the Arbuckles would be required to confirm the estimates of impacts following a high-use day.

Threshold volumes for benzene in 2012 would be lower than in 2002, despite an increase in the numbers of personal watercraft and other motorboats, but they would still be greater than the available water volumes in both areas. Threshold volumes would be 110,000 acre-feet in area 1 (66,400 ac-ft available) and 8,900 acre-feet in area 2 (6,000 ac-ft available), resulting in moderate adverse impacts in both areas. It would require up to five hours for benzene concentrations of benzene to fall below the human health benchmarks following a high-use day. Because benzene concentrations are likely to exceed human health benchmarks for several hours following a high-use day for personal watercraft and other motorboats, impacts would be moderate. Again, monitoring of water quality for benzene in Lake of the Arbuckles would be required to confirm the estimates of impacts following a high-use day.

Conclusion. Continuing PWC use would have negligible adverse impacts on water quality based on eco-toxicological benchmarks in 2002 and 2012 and on human health benchmarks (benzo(a)pyrene). The impact from benzene, based on human health benchmarks, would be minor in Lake of the Arbuckles (area 1) in both 2002 and 2012; in the no-wake zones (area 2) the impact would be moderate in 2002, decreasing to minor in 2012.

On a cumulative basis all pollutant loads in 2002 and 2012 from PWC and other motorboat use based on ecotoxicological benchmarks would be negligible. Based on human health benchmarks, water quality impacts from benzo(a)pyrene would be negligible in 2002 and 2012; but water quality impacts from benzene could be potentially major in 2002 in Lake of the Arbuckles (area 1) and the no-wake zones (area 2). In 2002 it could take up to 10 hours for benzene concentrations to be reduced below the human health benchmark as a result of mixing and dilution. By 2012 impacts from benzene would decrease to moderate in both areas. Impacts from benzene could be greater if a strong thermocline developed, effectively limiting the volume of water available for mixing and dilution. Monitoring of water quality for benzene would be required to confirm the estimates of impacts following a high-use day. Impacts in the no-wake zones could be reduced by the inflow of water from the streams feeding the lake.

Alternative A is not expected to result in an impairment of the water quality resource.

Impacts of Alternative B — Continue PWC Use under a Special Regulation with Additional Management Prescriptions

Analysis. PWC use would continue within the lake, but a slightly larger no-wake zone would be designated around the Buckhorn developed area. Overall numbers of personal watercraft would remain the same as in alternative A, with maximum use projected to increase from 135 per day in 2002 to 148 per day in 2012. Personal watercraft would operate in the areas permitted for their use, but because of the slightly larger no-wake zone, this area would increase to 6,240 acre-feet, compared to 6,000 acre-feet under alternative A (see Table 22). The distribution of personal watercraft between areas 1 and 2 would be the same as in alternative A (see Table 19), and emission rates in 2012 are assumed to be 50% of those in 2002. Threshold volumes of water needed to dilute PWC pollutants are shown in Table 22.

The calculated threshold volumes (both ecotoxicological and human health) would be the same as in alternative A. Impacts would be negligible for all compounds under ecotoxicological benchmarks and for benzo(a)pyrene under human health benchmarks in 2002 and 2012.

Impacts from benzene in area 1 under human health benchmarks would be minor in 2002 and 2012 (the threshold volume would decrease from of 45,000 ac-ft to 25,000 ac-ft, with 66,160 ac-ft available). In area 2 a threshold volume of 7,800 acre-feet would be needed to dilute benzene concentrations in 2002, exceeding the available volume (6,240 acre-feet) and resulting in a moderate impact; by 2012 the threshold volume would be reduced to 4,300 acre-feet, with a minor adverse impact. As explained for alternative A, half the benzene in water would evaporate in less than five hours, reducing the impact. Impacts from benzene in Lake of the Arbuckles could be greater if a strong thermocline became established, effectively limiting the volume of water available for mixing and dilution.

TABLE 22: THRESHOLD WATER VOLUMES NEEDED TO DILUTE PWC EMISSIONS, ALTERNATIVE B

	Lake of the Arbuckles (minus no-wake zones) — Area 1		No-Wake Zones (Upper Guy Sandy, Rock Creek, and Buckhorn Creek areas of Lake of the Arbuckles) — Area 2	
	2002	2012	2002	2012
NPS waters open to PWC use (ac-ft):	66,160		6,240	
Ecotoxicological Benchmarks*				
Benzo(a)pyrene (fuel and exhaust)	440	240	76	42
Naphthalene	180	96	30	16
1-methyl naphthalene	500	270	86	47
Benzene	420	230	72	39
Human Health Benchmarks**				
Benzo(a)pyrene (fuel and exhaust)	1,400	770	240	130
Benzene	45,000	25,000	7,800	4,300

* Threshold volumes (ac-ft) below which ecotoxicological effects might occur.
** Threshold volumes (ac-ft) below which human health might be impacted.

Cumulative Impacts. As described for alternative A, other two-stroke outboard motorboats would contribute pollutants to the water in addition to personal watercraft. Numbers of motorboats using the lake during a high-use day would increase from 335 per day in 2002 to 370 per day in 2012 and would be distributed as shown in Table 19. As described under the assumptions, PWC and motorboat emission rates in 2012 would be 50% of the 2002 rates. Threshold volumes needed to dilute emissions on a cumulative basis are shown in Table 23.

TABLE 23: THRESHOLD WATER VOLUMES NEEDED TO DILUTE PWC AND MOTORIZED BOAT EMISSIONS, ALTERNATIVE B

	Lake of the Arbuckles (minus no-wake zones) — Area 1		No-Wake Zones (Upper Guy Sandy, Rock Creek, and Buckhorn Creek areas of Lake of the Arbuckles) — Area 2	
	2002	2012	2002	2012
NPS waters open to motorboat use (ac-ft):	66,160		6,240	
Ecotoxicological Benchmarks*				
Benzo(a)pyrene (fuel and exhaust)	2,000	1,100	160	87
Naphthalene	780	430	63	34
1-methyl naphthalene	2,200	1,200	180	98
Benzene	1,900	1,000	150	82
Human Health Benchmarks**				
Benzo(a)pyrene (fuel and exhaust)	6,300	3,500	510	280
Benzene	200,000	110,000	16,000	8,900

* Threshold volumes (ac-ft) below which ecotoxicological effects might occur.
** Threshold volumes (ac-ft) below which human health might be impacted.

In 2002 and 2012 the threshold volumes needed to dilute personal watercraft and motorboat emissions would be the same as in alternative A and would be negligible for all ecotoxicological benchmarks and for benzo(a)pyrene under human health benchmarks.

As in alternative A, impacts from benzene based on human health benchmarks could be potentially major in 2002 because threshold volumes would be approximately three times the available volumes in areas 1 and 2. Impacts in Lake of the Arbuckles due to benzene could be greater if a strong thermocline became established. Conversely, impacts in the no-wake zones could be reduced by the inflow of water from the streams feeding the lake.

Despite a decrease in emission rates for personal watercraft and outboard motorboats, cumulative threshold volumes for benzene in 2012 (based on the human health benchmark) would still be greater than the available water volumes in areas 1 and 2. The threshold volume in area 1 would be 110,000 acre-feet (with 66,160 ac-ft available); and in area 2, 8,900 ac-ft (6,240 ac-ft available), resulting in potentially moderate adverse impacts in both areas. It would take up to five hours for benzene concentrations to fall below the human health benchmark following a high-use day. Monitoring of water quality for benzene in Lake of the Arbuckles would be required to confirm the estimates of impacts following a high-use day.

Conclusion. Continuing PWC use with additional management restrictions would have negligible adverse impacts on water quality in 2002 and 2012 based on all ecotoxicological benchmarks and on the human health benchmark for benzo(a)pyrene. PWC impacts to water quality from benzene in Lake of the Arbuckles (area 1) would be minor in 2002 and 2012; impacts in the no-wake zones (area 2) would be potentially moderate in 2002, decreasing to minor in 2012.

Cumulative water quality impacts would be negligible in 2002 and 2012 except for benzene under the human health benchmark. Cumulative impacts from benzene could be potentially major in 2002, decreasing to moderate in 2012 in areas 1 and 2 as a result of improved engine technology. Benzene impacts in Lake of the Arbuckles could be greater if a strong thermocline became established, reducing the volume of water available for mixing and dilution. Conversely, impacts in the no-wake zones (area 2) could be reduced by the inflow of water from the streams feeding the lake. Monitoring of water quality for benzene in Lake of the Arbuckles would be required to confirm the estimates of impacts following a high-use day. Impacts would also be reduced by prohibiting refueling operations on the water.

Alternative B is not expected to result in an impairment of the water quality resource.

Impacts of Alternative C — Continue PWC Use but Limit Area of Use and Implement Other Restrictions

Analysis. PWC use would continue within Lake of the Arbuckles, but all personal watercraft would have to meet the U.S. EPA emissions requirements (which call for a 75% reduction of hydrocarbon emissions) by April 15, 2005. Other motorboats would not be required to meet this requirement, and by 2012 an overall 50% reduction in emissions is assumed for outboard motors. In addition, personal watercraft would be excluded from the previously described no-wake zones in Upper Guy Sandy and in Rock Creek (see the Alternative C map). Personal watercraft could continue to operate in the Buckhorn Creek arm of the lake and the Buckhorn developed area under no-wake speed restrictions. Alternative C could also limit the number of personal watercraft; however, this analysis assumes that this is not yet occurring and that overall PWC numbers would remain the same as in alternatives A and B, with maximum use projected to increase from 135 per day in 2002 to 148 per day in 2012 (see Table 19). PWC use would only be allowed in areas 1 and 2; no personal watercraft would be allowed in area 3. Threshold volumes of water to dilute PWC emissions are shown in Table 24.

TABLE 24: THRESHOLD WATER VOLUMES NEEDED TO DILUTE PWC EMISSIONS, ALTERNATIVE C

	Lake of the Arbuckles (minus no-wake and PWC-prohibited zones) — Area 1		No-Wake Zones (Buckhorn Creek portion of Lake of the Arbuckles) — Area 2		PWC-Prohibited Zones (Upper Guy Sandy and Rock Creek) — Area 3	
	2002	2012	2002	2012	2002	2012
NPS waters open to PWC use (ac-ft):	64,675		4,125		3,600	
Ecotoxicological Benchmarks*						
Benzo(a)pyrene (fuel and exhaust)	610	170	35	10	--	--
Naphthalene	240	66	14	4	--	--
1-methyl naphthalene	690	190	39	11	--	--
Benzene	580	160	33	9	--	--
Human Health Benchmarks**						
Benzo(a)pyrene (fuel and exhaust)	1,900	530	110	31	--	--
Benzene	62,000	17,000	3,500	990	--	--

* Threshold volumes (ac-ft) below which ecotoxicological effects might occur.

** Threshold volumes (ac-ft) below which human health might be impacted.

Under alternative C the 2002 and 2012 estimated threshold volumes for PWC emissions (based on both ecotoxicological and human health benchmarks) would be higher in Lake of the Arbuckles than under alternative A or B because use would be displaced from the Upper Guy Sandy and Rock Creek arms to the major portion of the lake. Threshold volumes for the Buckhorn Creek no-wake zone (area 2) would be less because of fewer watercraft in this area. Water quality impacts in 2002 are expected to be negligible under all ecotoxicological benchmarks and for benzo(a)pyrene under human health benchmarks. Impacts from benzene under human health benchmarks would be potentially moderate in 2002 in both areas 1 and 2, with a threshold volume of 62,000 acre-feet in Lake of the Arbuckles (area 1, 64,675 ac-ft available) and 3,500 acre-feet in the no-wake zones (area 2, 4,125 ac-ft available). In 2012, threshold volumes would be substantially less than under alternative A because a 75% emission reduction is expected as a result of stipulating stricter emission standards for personal watercraft used in the park beginning in 2005. Therefore, impacts in 2012 would be negligible based on all ecological and human health benchmarks.

Cumulative Impacts. Under alternative C the total number of other motorboats in addition to personal watercraft would be the same as in the previous alternatives — 335 in 2002 and 370 in 2012. They would be distributed as shown in Table 19. Motorboats in areas 2 and 3 would operate at no-wake speeds. Required threshold volumes to dilute pollutants are shown in Table 25.

TABLE 25: THRESHOLD WATER VOLUMES NEEDED TO DILUTE PWC AND MOTORIZED BOAT EMISSIONS, ALTERNATIVE C

	Lake of the Arbuckles (minus no-wake and PWC-prohibited zones) — Area 1		No-Wake Zones (Buckhorn Creek portion of Lake of the Arbuckles) — Area 2		PWC-Prohibited Zones (Upper Guy Sandy and Rock Creek) — Area 3*	
	2002	2012	2002	2012	2002	2012
NPS waters open to motorboat use (ac-ft):	64,675		4,125		3,600	
Ecotoxicological Benchmarks**						
Benzo(a)pyrene (fuel and exhaust)	2,100	1,000	62	25	55	30
Naphthalene	840	400	25	10	22	12
1-methyl naphthalene	2,400	1,100	70	28	62	34
Benzene	2,000	950	59	24	52	29
Human Health Benchmarks***						
Benzo(a)pyrene (fuel and exhaust)	6,800	3,200	200	79	180	97
Benzene	220,000	100,000	6,400	2,600	5,700	3,100

* Only personal watercraft would not be permitted in Upper Guy Sandy and Rock Creek under alternative C.

** Threshold volumes (ac-ft) below which ecotoxicological effects might occur.

*** Threshold volumes (ac-ft) below which human health might be impacted.

Cumulative water quality impacts under alternative C in 2002 would be negligible for all ecotoxicological benchmarks and for benzo(a)pyrene under the human health benchmarks in all three areas. Similar to alternatives A and B, impacts in 2002 from benzene (under the human health benchmark) could be potentially major in Lake of the Arbuckles (area 1) because threshold volumes would be more than three times the available volume. It would take up to 10 hours for benzene to evaporate from the water, given its five-hour half-life. Impacts from benzene in Lake of the Arbuckles (area 1) could be greater if a strong thermocline became established, thus reducing the volume of water available for mixing and dilution. Human-health based impacts from benzene would be moderate in areas 2 and 3 in 2002.

Cumulative threshold volumes in 2012 under alternative C would be slightly higher in area 1 but lower in area 2 than under either alternative A or B. Water quality impacts in 2012 would be negligible based on all ecotoxicological benchmarks and on the human health benchmark for benzo(a)pyrene. Despite a decrease in emission rates for personal watercraft, the cumulative threshold volume in 2012 for benzene under human health benchmarks in Lake of the Arbuckles (area 1) would be 100,000 acre-feet, greater than the available water volume (64,675 ac-ft). In the PWC prohibited areas (area 3) the threshold volume would be 3,100 acre-feet (3,600 ac-ft available). It would take up to five hours for benzene concentrations to fall below the human health benchmark following a high-use day. Because benzene concentrations from personal watercraft and other motorboats would likely exceed the human health benchmark for several hours, impacts in areas 1 and 3 in 2012 would be potentially moderate, while impacts in the no-wake zones (area 2) would be minor.

Conclusion. Under alternative C water quality impacts from PWC use in 2002 and 2012 would be negligible for all ecotoxicological benchmarks and for benzo(a)pyrene under human health benchmarks. Impacts from benzene under human health benchmarks would be moderate in 2002, decreasing to negligible by 2012.

Cumulative water quality impacts in 2002 and 2012 would be negligible under all ecotoxicological benchmarks and for benzo(a)pyrene under human health benchmarks in all areas. Impacts from benzene in 2002 under human health benchmarks could be potentially major in Lake of the Arbuckles (area 1) and moderate in the no-wake zones (areas 2) and PWC use prohibited zones (area 3). By 2012 impacts from benzene are expected to decrease to moderate in areas 1 and 3 and to minor in area 2. Impacts from benzene in Lake of the Arbuckles (area 1) could be greater if a strong thermocline developed, thus reducing the volume of water available for mixing and dilution. Monitoring of water quality for benzene in Lake of the Arbuckles could be required to confirm the estimates of impacts following a high-use day. Impacts in the no-wake zones (area 2) could be reduced by the inflow of water from the streams feeding the lake. Impacts would also be reduced by prohibiting refueling operations on the water.

Alternative C is not expected to result in an impairment of the water quality resource.

Impacts of the No-Action Alternative — No PWC Use

Analysis. No PWC use would be allowed within Chickasaw National Recreation Area. Therefore, personal watercraft would not contribute pollutants to Lake of the Arbuckles. As a result, the no-action alternative would have a beneficial impact on water quality.

Cumulative Impacts. The number of motorboats on an average high-use day on Lake of the Arbuckles would be the same as described under the previous alternatives, an estimated 335 boats in 2002 increasing to 370 boats in 2012 (see Table 19). Threshold volumes required to dilute pollutant of all other motorized boats on Lake of the Arbuckles under the no-action alternative are shown in Table 26.

TABLE 26: THRESHOLD WATER VOLUMES NEEDED TO DILUTE MOTORIZED BOAT EMISSIONS, NO-ACTION ALTERNATIVE

	Lake of the Arbuckles (minus no-wake zones) — Area 1		No-Wake Zones (Upper Guy Sandy, Rock Creek, and Buckhorn Creek portions of Lake of the Arbuckles) — Area 2	
	2002	2012	2002	2012
NPS waters open to motorboat use (ac-ft):	66,400		6,000	
Ecotoxicological Benchmarks*				
Benzo(a)pyrene (fuel and exhaust)	1,500	840	83	46
Naphthalene	600	330	33	18
1-methyl naphthalene	1,700	950	94	51
Benzene	1,400	800	79	43
Human Health Benchmarks**				
Benzo(a)pyrene (fuel and exhaust)	4,800	2,700	260	150
Benzene	160,000	86,000	8,500	4,700

* Threshold volumes (ac-ft) below which ecotoxicological effects might occur.

** Threshold volumes (ac-ft) below which human health might be impacted.

Cumulative emissions from all motorized boat use on Lake of the Arbuckles would be less than under the other alternatives because PWC use would not contribute to the pollutant load. Threshold volumes in both areas in 2002 and 2012 based on ecotoxicological benchmarks and on the human health benchmark for benzo(a)pyrene would be substantially lower than the water volumes available, resulting in negligible adverse impacts on water quality.

Impacts from benzene in Lake of the Arbuckles (area 1) could be potentially major in 2002, decreasing to moderate by 2012. In the no-wake zones (area 2) impacts would be moderate in 2002, decreasing to minor by 2012. As described for the other alternatives, impacts in Lake of the Arbuckles could be greater if a strong thermocline developed. Monitoring of water quality for benzene in Lake of the Arbuckles could be required to confirm the estimates of impacts following a high-use day.

Conclusion. Discontinuing PWC use would have a beneficial impact on water quality because pollutant loads from personal watercraft would be eliminated.

Cumulative impacts from all other motorboats would be negligible under all ecotoxicological benchmarks and for benzo(a)pyrene under the human health benchmark. Impacts from benzene under the human health criteria in Lake of the Arbuckles (area 1) could be potentially major in 2002, decreasing to moderate by 2012. In the no-wake zones (area 2), impacts would be moderate in 2002, decreasing to minor by 2012. Impacts in Lake of the Arbuckles could be greater if a strong thermocline developed. Monitoring of water quality for benzene in Lake of the Arbuckles could be required to confirm the estimates of impacts following a high-use day.

This alternative is not expected to result in an impairment of the water resource.

AIR QUALITY

Personal watercraft emit various compounds that pollute the air. In the two-stroke engines commonly used in PWC, the lubricating oil is used once and is expelled as part of the exhaust; and the combustion process results in emissions of air pollutants such as volatile organic compounds (VOC), nitrogen oxides (NO_x), particulate matter (PM), and carbon monoxide (CO). Personal watercraft also emit fuel components such as benzene that are known to cause adverse health effects. Even though PWC engine exhaust is usually routed below the waterline, a portion of the exhaust gases go into the air. These air

pollutants may adversely impact park visitor and employee health, as well as sensitive park resources. For example, in the presence of sunlight VOC and NO_x emissions combine to form ozone. Ozone causes respiratory problems in humans, including cough, airway irritation, and chest pain during inhalation (US EPA 1996c). Ozone is also toxic to sensitive species of vegetation. It causes visible foliar injury, decreases plant growth, and increases plant susceptibility to insects and disease (US EPA 1996c). Carbon monoxide can affect humans as well. It interferes with the oxygen carrying capacity of blood, resulting in lack of oxygen to tissues. NO_x and PM emissions associated with PWC use can also degrade visibility (CARB 1997; US EPA 2000b). NO_x can also contribute to acid deposition effects on plants, water, and soil. However, because emission estimates show that NO_x from personal watercraft are minimal (less than 5 tons per year), acid deposition effects attributable to personal watercraft use are expected to be minimal.

GUIDING REGULATIONS AND POLICIES

Clean Air Act. The Clean Air Act establishes national ambient air quality standards (NAAQS) to protect the public health and welfare from air pollution. The act also establishes the prevention of significant deterioration (PSD) of air quality program to protect the air in relatively clean areas. One purpose of this program is to preserve, protect, and enhance air quality in areas of special national or regional natural, recreational, scenic, or historic value (42 USC 7401 et seq.). The program also includes a classification approach for controlling air pollution.

Chickasaw National Recreation Area is designated a class II area. The Clean Air Act allows only moderate air quality deterioration in class II areas. In no case, however, may pollution concentrations violate any of the national ambient air quality standards. In contrast, in class I areas very little deterioration of air quality is allowed, and the unit manager has an affirmative responsibility to protect visibility and all other class I area air quality related values from the adverse effects of air pollution.

Conformity Requirements. National park system areas that do not meet the national ambient air quality standards or whose resources are already being adversely affected by current ambient levels require a greater degree of consideration and scrutiny by NPS managers. Areas that do not meet national air quality standards for any pollutant are designated as nonattainment areas. Section 176 of the Clean Air Act states:

> No department, agency, or instrumentality of the Federal Government shall engage in, support in any way or provide financial assistance for, license or permit, or approve, any activity which does not conform to an implementation plan [of the state]. . . . [T]he assurance of conformity to such a plan shall be an affirmative responsibility of the head of such department, agency or instrumentality.

Essentially, federal agencies must ensure that any action taken does not interfere with a state's plan to attain and maintain the national ambient air quality standards in designated nonattainment and maintenance areas.

Chickasaw National Recreation Area is an attainment area for all pollutants, so the conformity requirements do not apply to this unit.

Applicable PWC Emission Standards. The Environmental Protection Agency issued the gasoline marine engine final rule in August 1996. The rule, which took effect in 1999, affects manufacturers of new outboard engines and the type of inboard engines used in personal watercraft. The agency adopted a phased approach to reduce emissions. The current emission standards were set at levels that are achievable by existing personal watercraft. By 2006 PWC manufacturers will be required to meet a corporate average emission standard that is equivalent to a 75% reduction in VOC emissions. (The corporate average standard allows manufacturers to build some engines to emission levels lower than the standard

and some engines to emission levels higher than the standard, and to employ a mix of technology types, as long as the overall corporate average is at or below the standard.) Because the actual reduction in emissions is dependent on the sale of lower-emitting personal watercraft, the Environmental Protection Agency estimates that a 52% emission reduction will be achieved by 2011 and a 75% emission reduction achieved by 2031 (US EPA 1996a, 1997).

In July 2002 the Environmental Protection Agency proposed new evaporative emissions standards for gasoline-fueled boats and personal watercraft. These proposed standards would require most new boats produced in 2008 or later to be equipped with low-emission fuel tanks or other evaporative emission controls.

NPS Organic Act and Management Policies. The NPS Organic Act of 1916 (16 USC 1 et seq.) and the NPS *Management Policies* guide the protection of park and wilderness areas. The general mandates of the Organic Act state that the National Park Service will

> promote and regulate the use of . . . national parks . . . by such means and measures as conform to the fundamental purpose of the said parks, . . . which purpose is to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations (16 USC 1).

Under its *Management Policies 2001* the National Park Service will

> seek to perpetuate the best possible air quality in parks to (1) preserve natural resources and systems; (2) preserve cultural resources; and (3) sustain visitor enjoyment, human health, and scenic vistas (sec. 4.7.1).

The *Management Policies* further state that the National Park Service will assume an aggressive role in promoting and pursuing measures to protect air quality related values from the adverse impacts of air pollution. In cases of doubt as to the impacts of existing or potential air pollution on park resources, the National Park Service "will err on the side of protecting air quality and related values for future generations."

The Organic Act and the *Management Policies* apply equally to all areas of the national park system, regardless of Clean Air Act designations. Therefore, the National Park Service will protect resources at class II designated units. Furthermore, the NPS Organic Act and *Management Policies* provide additional protection beyond that afforded by the Clean Air Act's national ambient air quality standards alone because the National Park Service has documented that specific park air quality related values can be adversely affected at levels below the national standards or by pollutants for which no standard exists.

METHODOLOGY AND ASSUMPTIONS

In order to assess the level of PWC air quality impacts resulting from a given management alternative, the following methods and assumptions were used:

1. The national ambient air quality standards and state/local air quality standards (if applicable) were examined for each pollutant (the standards are included on page 50).
2. Air quality designations for the surrounding area were determined. Chickasaw National Recreation Area is in an attainment area for each pollutant.

3. The nearest monitoring location to Chickasaw National Recreation Area is the Lake Murray monitoring site approximately 20 miles away. Based on data from this site, all highest maximum concentrations for each pollutant are below the national ambient air quality standards, except that monitoring data show that the 8-hour ozone standard is periodically exceeded at this location.
4. Typical use patterns of motorized watercraft were identified (see "PWC Use Trends" section).
5. The rated horsepower, average engine load, deterioration factors, and other relevant parameters for each watercraft type were taken from default assumptions in the EPA Nonroad model. (This model is used to calculate emissions of criteria pollutants from the operation of nonroad spark-ignition type engines, including personal watercraft. The model allows assumptions to be made regarding the mix of engine types that will be phased in as new engine standards come into effect, and increasing numbers of personal watercraft will be the cleaner-burning four-stroke type. Total hydrocarbon emissions comprise approximately 103% of the VOC for two-stroke engines and 93% of the VOC for four-stroke engines [US EPA 1997; US EPA 2000b].)
6. Any reductions in emissions resulting from implementing control strategies were taken into account, as were changes in emissions resulting from increased or decreased usage.
7. Studies regarding ozone injury on sensitive plants found in the recreational area were requested, but none were available for Chickasaw.
8. A calculation referred to as SUM06 (ppm-hours) was used for assessing regional ozone exposure levels. These data are collected from rural and urban monitoring sites. The highest three-month, five-year average commonly used for the area was determined by reviewing ambient air quality data (available from the NPS Air Resources Division).
9. Visibility impairment was determined from local monitoring data, or from qualitative evidence such as personal observations and photographs.
10. The air quality impacts of the various alternatives were assessed by considering the existing air quality levels and the air quality related values present, and by using the estimated emissions and any applicable, EPA-approved air quality models. Estimated reductions in hydrocarbon emissions would be the same as those described for water quality.
11. For cumulative impacts, the assessment was completed quantitatively with respect to anticipated use of the recreational area by other recreational watercraft based on emission factors and assumption in EPA's Nonroad model. Types of craft assessed for quantitative cumulative impacts included outboard spark-ignition type engines, as well as personal watercraft. Other sources of air pollutants in the area were also considered in the cumulative analysis through a review of the state implementation plan, county records, and the use of best professional judgment.
12. For alternative C, the assumption is a 75% reduction for personal watercraft in 2005 and 2012 and for a 50% reduction for outboards in 2012.

PWC impact thresholds for air quality are dependent on the type of pollutants produced, the background air quality, and the pollution-sensitive resources (air quality related values) present. Impact thresholds may be qualitative (e.g., photos of degraded visibility) or quantitative (e.g., based on impacts to air quality related values or federal air quality standards, or emissions based), depending on what type of information is appropriate or available.

PWC impact thresholds for air quality depend on the type of pollutants produced, the background air quality, and the resources in the environmental that may be affected by airborne pollutants (air quality related values). Air quality related values include "visibility and those scenic, cultural, biological, and recreation resources of an area that are affected by air quality" (43 FR 15016).

Impact thresholds may be qualitative, such as photos of degraded visibility, or quantitative, based on impacts on air quality related values or federal air quality standards, or emissions based on emission factor models. The type of thresholds used in an analysis depends on what type of information is appropriate or available. Because the U.S. Environmental Protection Agency has established standards that are regulated by states to protect human health and the environment, two categories of potential airborne pollution impacts from personal watercraft are analyzed: impacts on human health resources, and impacts on air quality related values in the study area. Thresholds for each impact category are discussed separately.

IMPACT ANALYSIS AREA

The impact analysis area includes the immediate location of PWC use and the surrounding recreational area where air pollutants may accumulate. For purposes of this review, the impact analysis area is Lake of the Arbuckles plus a 100-foot-wide strip inland. It is assumed that air pollutants would dissipate beyond 100 feet due to air currents.

IMPACT TO HUMAN HEALTH FROM AIRBORNE POLLUTANTS RELATED TO PWC USE

The following impact thresholds for an attainment area have been defined for analyzing impacts to human health from airborne pollutants — CO, PM_{10}, total hydrocarbons (HC), and ozone (O_3). Sulfur oxides (SO_x) are not included because they are emitted by personal watercraft in very small quantities.

	Activity Analyzed		**Current Air Quality**
Negligible:	Emissions would be less than 50 tons/year for each pollutant.	**and**	The first highest three-year maximum for each pollutant is less than NAAQS.
Minor:	Emissions would be less than 100 tons/year for each pollutant.	**and**	The first highest three-year maximum for each pollutant is less than NAAQS.
Moderate:	Emissions would be greater than or equal to 100 tons/year for any pollutant.	**or**	The first highest three-year maximum for each pollutant is greater than NAAQS.
Major:	Emissions levels would be greater than or equal to 250 tons/year for any pollutant.	**and**	The first highest three-year maximum for each pollutant is greater than NAAQS.

Impairment: Impacts would

have a major adverse effect on park resources and values; or

contribute to deterioration of the park's air quality to the extent the park's purpose could not be fulfilled as established in its enabling legislation; or

affect resources key to the park's natural or cultural integrity or opportunities for enjoyment; or

affect the resource whose conservation is identified as a goal in the park's general management plan or other park planning documents.

Both VOC and NO_x are ozone precursors in the presence of sunlight and are evaluated separately in lieu of ozone, which is formed as a secondary pollutant. (Note that in attainment areas the Clean Air Act does not require that NO_x be counted as an ozone precursor). Total HC is not a criteria pollutant, so no impact threshold is assigned; total HC emissions are included in the analysis for information because they are the target of the EPA regulations.

Impacts of Alternative A — Continue PWC Use under a Special NPS Regulation

Analysis. Under this alternative there would be no locational restrictions or changes in speed limits for personal watercraft. Current no-wake zones would be maintained. Based on data collected by NPS staff, PWC annual use was estimated to be 8,294 watercraft in 2002, increasing at approximately 1% per year to 9,162 in 2012. The impacts of continued PWC use within the recreation area are presented in Table 27.

TABLE 27: PWC EMISSIONS AND HUMAN HEALTH IMPACT LEVELS, ALTERNATIVE A

	CO		PM_{10}		HC		VOC		NO_x	
	2002	2012	2002	2012	2002	2012	2002	2012	2002	2012
Annual Emissions (tons/year)	158.1	145.3	3.6	3.0	73.2	45.1	75.7	46.4	0.6	1.6
Impact Level	Moderate	Moderate	Negligible	Negligible	Information only	Information only	Minor	Negligible	Negligible	Negligible

Adverse impact levels in 2002 would be moderate for CO as emissions would exceed 100 tons/year, minor for VOC as emissions would exceed 50 tons/year, and negligible for PM_{10} and NO_x.

For 2012 impact levels take into account the predicted 1% per year increase, as well as an approximately 50% improvement in engine total HC emission rates compared to 1998 due to use of cleaner burning engines, in accordance with the U.S. EPA standards. Future impact levels would be in the same categories as 2002, with the exception of VOC, which would be reduced to a negligible impact level due to the significant reductions in HC emissions. Other pollutants would also decrease, except for NO_x, which is predicted to increase by a small factor in four-stroke engines.

Cumulative Impacts. Other motorized watercraft are assessed quantitatively in combination with personal watercraft, taking into consideration regional and local air pollution sources. Other watercraft at Chickasaw are assumed to be primarily outboards and are more abundant within the recreation area than are personal watercraft. During 2002 NPS data indicate there were 21,865 motorboats per year; assuming a 1% per year increase, there would be 24,154 boats in 2012. The combined emissions from personal watercraft and other boats are provided in Table 28.

TABLE 28: PWC AND MOTORIZED BOAT EMISSIONS AND HUMAN HEALTH IMPACT LEVELS, ALTERNATIVE A

	CO		PM_{10}		HC		VOC		NO_x	
	2002	2012	2002	2012	2002	2012	2002	2012	2002	2012
Annual Emissions (tons/year)	375.3	375.5	7.4	7.2	115.9	68.7	119.5	70.5	4.2	6.3
Impact Level	Moderate	Moderate	Negligible	Negligible	Information only	Information only	Moderate	Minor	Negligible	Negligible

In 2002 cumulative impact levels for PM_{10} and NO_x would be negligible, while levels for CO and VOC would be moderate. Even though monitoring data are not available for CO in the area of Chickasaw, ambient CO levels are assumed to be below the national ambient air quality standard within this area. By

2012 emission rates would be reduced as a result of technological improvements. CO emissions would remain at a moderate level, and VOC impacts would decrease to minor. NO_x emissions would increase slightly, with the associated impact remaining at a negligible level.

Conclusion. Continuing PWC use at Chickasaw would result in a moderate adverse impact from CO, a minor adverse impact from VOC, and negligible adverse impacts from PM_{10} and NO_x in 2002. In 2012 the impact from CO would remain moderate, while impacts from VOC, PM_{10}, and NO_x impacts would be negligible.

Cumulative emission levels would be negligible for PM_{10} and NO_x in 2002 and 2012. Cumulative impacts for CO emissions would be at a moderate level in both 2002 and 2012, while VOC emissions would have a moderate adverse impact in 2002, decreasing to minor in 2012. This alternative would maintain existing air quality conditions, with future reductions in PM_{10}, HC, and VOC emissions due to improved emission controls.

This alternative would not result in an impairment of air quality.

Impacts of Alternative B — Continue PWC Use under a Special Regulation with Additional Management Prescriptions

Analysis. Under this alternative the annual number of personal watercraft using Chickasaw would follow the same trends as alternative A, which assumes 8,294 personal watercraft in 2002, increasing to 9,162 in 2012. The predicted PWC use within the recreation area under this alternative reflects a small extension of the no-wake zone near the Buckhorn developed area, which would reduce emissions compared to alternative A. The impacts of continued PWC use within the recreation area are presented in Table 29.

TABLE 29: PWC EMISSIONS AND HUMAN HEALTH IMPACT LEVELS, ALTERNATIVE B

	CO		PM_{10}		HC		VOC		NO_x	
	2002	2012	2002	2012	2002	2012	2002	2012	2002	2012
Annual Emissions (tons/year)	156.9	144.2	3.5	3.0	72.6	44.7	75.1	46.0	0.6	1.6
Impact Level	Moderate	Moderate	Negligible	Negligible	Information only	Information only	Minor	Negligible	Negligible	Negligible

Adverse impact levels in 2002 would be moderate for CO (emissions would exceed 100 tons/year), minor for VOC (emissions would exceed 50 tons/year, and negligible for PM_{10} and NO_x. In 2012 emissions would be reduced for all compounds except NO_x, but the impact would remain moderate for CO, while the impact for VOC would decrease to negligible, and impacts for PM_{10} and NO_x would remain negligible.

Cumulative Impacts. Cumulative impacts would be similar to alternative A. Cumulative impacts are shown in Table 30.

TABLE 30: PWC AND MOTORIZED BOAT EMISSIONS AND HUMAN HEALTH IMPACT LEVELS, ALTERNATIVE B

	CO		PM_{10}		HC		VOC		NO_x	
	2002	2012	2002	2012	2002	2012	2002	2012	2002	2012
Annual Emissions (tons/year)	374.1	374.4	7.4	7.2	115.3	68.4	118.9	70.1	4.2	6.2
Impact Level	Moderate	Moderate	Negligible	Negligible	Information only	Information only	Moderate	Minor	Negligible	Negligible

CO impact levels would be moderate (greater than 250 tons/year but not exceeding the third highest national ambient air quality standard) in both 2002 and 2012. Emission rates of PM_{10} and VOC would be reduced between 2002 and 2012; the impact from VOC would be moderate in 2002 and minor in 2012, while the impact from PM_{10} would be negligible in both years. NO_x emissions would increase slightly, with the associated impact remaining at a negligible level. This alternative would maintain existing air quality conditions, with future reductions in PM_{10}, HC, and VOC emissions due to improved emission controls.

Conclusion. Continuing PWC use at Chickasaw would result in a moderate adverse impact from CO, a minor adverse impact from VOC, and negligible adverse impacts from PM_{10} and NO_x in 2002. In 2012 the impact level for CO would remain moderate adverse, and VOC, PM_{10}, and NO_x impacts would be negligible. Extending the no-wake zone in the area of the Buckhorn developed area would reduce the emissions of all pollutants except NO_x in comparison to alternative A.

Cumulative emission levels for CO would be moderate adverse in both 2002 and 2012. Impacts for VOC would decrease from moderate in 2002 to minor in 2012, while impacts for PM_{10} and NO_x would be negligible. This alternative would maintain existing air quality conditions, with future reductions in PM_{10}, HC, and VOC emissions due to improved emission controls.

This alternative would not result in an impairment of air quality.

Impacts of Alternative C — Continue PWC Use but Limit Area of Use and Implement Other Restrictions

Analysis. Under this alternative the annual number of personal watercraft using Chickasaw would follow the same trends as alternatives A and B, which assumes 8,294 personal watercraft in 2002 and 9,162 in 2012. PWC use would be limited to the body and some arms of Lake of the Arbuckles. Current no-wake zones, with associated 5 mph speed restrictions, would be expanded, resulting in additional reductions in emissions due to reduced overall engine load in the recreation area. Under this alternative all older two-stroke carbureted PWC engines would be banned by 2005 and would have to be replaced by engines that meet the EPA 2006 standards. The impacts of continued PWC use within the recreation area are presented in Table 27.

TABLE 31 : PWC EMISSIONS AND HUMAN HEALTH IMPACT LEVELS, ALTERNATIVE C

	CO		PM_{10}		HC		VOC		NO_x	
	2002	2012	2002	2012	2002	2012	2002	2012	2002	2012
Annual Emissions (tons/year)	111.6	83.5	2.5	1.5	51.7	8.6	53.4	8.6	0.4	1.7
Impact Level	Moderate	Minor	Negligible	Negligible	Information only	Information only	Minor	Negligible	Negligible	Negligible

There would be a moderate adverse impact from CO in 2002 (emissions would exceed 100 tons/year), decreasing to minor by 2012. Impacts for VOC emissions would be minor adverse in 2002 (more than 50 tons/year), decreasing to negligible by 2012. Impacts from for PM_{10} and NO_x would be negligible throughout the assessment period.

Cumulative Impacts. Impacts from all motorized craft, as well as personal watercraft, are shown in Table 32.

TABLE 32: PWC AND MOTORIZED BOAT EMISSIONS AND HUMAN HEALTH IMPACT LEVELS, ALTERNATIVE C

	CO		PM_{10}		HC		VOC		NO_x	
	2002	2012	2002	2012	2002	2012	2002	2012	2002	2012
Annual Emissions (tons/year)	328.8	313.7	6.4	5.8	94.3	32.2	97.2	32.7	4.0	6.4
Impact Level	Moderate	Moderate	Negligible	Negligible	Information only	Information only	Minor	Negligible	Negligible	Negligible

CO impact levels would be moderate adverse in both 2002 and 2012 (greater than 250 tons/year and below the third highest national ambient air quality standard). Emission rates of PM_{10} and VOC would be reduced between 2002 and 2012; VOC impacts would be minor adverse in 2002, decreasing to negligible in 2012, and PM_{10} impacts would be negligible in both years. NO_x emissions would increase slightly, with the associated impact remaining at a negligible level. This alternative would maintain existing air quality conditions, with future reductions in PM_{10}, HC, and VOC emissions due to improved emission controls.

Conclusion. Continuing PWC use at Chickasaw would result in a moderate adverse impact from CO, a minor adverse impact from VOC, and negligible adverse impacts from PM_{10} and NO_x in 2002. Emissions would be reduced compared to alternative A because no-wake zones would be extended and areas would be closed to PWC use. In 2012 impacts from CO would be minor due to an overall reduction in carbureted two-stroke engines, and impacts from VOC, PM_{10}, and NO_x would be negligible.

Cumulative emission levels would result in moderate adverse impacts from CO in both 2002 and 2012; minor adverse impacts from VOC in 2002, decreasing to negligible by 2012; and negligible adverse impacts from PM_{10} and NO_x. This alternative would maintain existing air quality conditions, with future reductions in PM_{10}, HC, and VOC emissions due to anticipated improved emission controls and banning two-stroke carbureted PWC engines in 2005.

This alternative would not result in an impairment of air quality.

Impacts of the No-Action Alternative — No PWC Use

Analysis. Under the no-action alternative PWC use would be no longer contribute to emissions of CO, PM_{10}, HC, VOC, and NO_x, resulting in beneficial impacts.

Cumulative Impacts. Impacts from the continued use of motorized boats are shown in Table 33.

TABLE 33: MOTORIZED BOAT EMISSIONS AND HUMAN HEALTH IMPACT LEVELS, NO-ACTION ALTERNATIVE

	CO		PM_{10}		HC		VOC		NO_x	
	2002	2012	2002	2012	2002	2012	2002	2012	2002	2012
Annual Emissions (tons/year)	217.2	230.2	3.9	4.3	42.7	23.6	43.8	24.1	3.6	4.7
Impact Level	Moderate	Moderate	Negligible	Negligible	Information Only	Information Only	Negligible	Negligible	Negligible	Negligible

Cumulative emissions for all other watercraft would be lower than the other alternatives due to the elimination of PWC use. Impacts would be moderate adverse for CO and negligible adverse for PM10, VOC, and NOx in both 2002 and 2012. In 2012 emissions from boats would decrease as manufacturers met EPA requirements.

Conclusion. Banning PWC use would have beneficial impacts on air quality because of decreased emissions.

Compared to alternative A, emissions from all other motorized watercraft would be reduced, with no contribution from PWC use. Impacts from CO would be moderate in 2002 and 2012, while impacts from PM_{10}, VOC, and NO_x would be negligible throughout the assessment period. With improved emission controls, future emissions of most pollutants would gradually decline, although NO_x emissions would increase slightly.

The no-action alternative would not impair air quality.

IMPACT TO AIR QUALITY RELATED VALUES FROM PWC POLLUTANTS

Impacts on environmental resources and values include visibility and biological resources (specifically, ozone effects on plants) that may be affected by airborne pollutants emitted from personal watercraft and other sources. These pollutants include ozone, nitrogen oxides, and particulate matter.

$PM_{2.5}$ as a fraction of particulate matter is evaluated for visibility impairment. To assess the impact of ozone on plants, the five-year ozone index value is used. This value is represented as SUM06 ozone measured in ppm-hours. The SUM06 values are interpreted and mapped by the NPS Air Resources Division based on data from rural and urban monitoring sites; they represent the overall condition of the area due to regional emissions of ozone precursor chemicals, and consequent formation of ozone. Local park-specific data were used to assess area specific ozone effects, when available.

	Activity Analyzed		**Current Air Quality**
Negligible:	Emissions would be less than 50 tons/year for each pollutant.	**and**	There are no perceptible visibility impacts (photos or anecdotal evidence). **and** There is no observed ozone injury on plants. **and** SUM06 ozone is less than 12 ppm-hours.
Minor:	Emissions would be less than 100 tons/year for each pollutant.	**and**	SUM06 ozone is less than 15 ppm-hour.
Moderate:	Emissions would be greater than 100 tons/year for any pollutant. **or** Visibility impacts from cumulative PWC emissions would be likely (based on past visual observations).	**or**	Ozone injury symptoms are identifiable on plants. **and** SUM06 ozone is less than 25 ppm-hours.

Major: Emissions would be equal to or greater than 250 tons/year for any pollutant.

or

Visibility impacts from cumulative PWC emissions would be likely (based on modeling or monitoring).

and Ozone injury symptoms are identifiable on plants.

or

SUM06 ozone is greater than 25 ppm-hours.

Impairment: Air quality related values in the park would be adversely affected. In addition, impacts would

have a major adverse effect on park resources and values;

contribute to deterioration of the park's air quality to the extent the park's purpose could not be fulfilled as established in its enabling legislation; or

affect resources key to the park's natural or cultural integrity or opportunities for enjoyment; or

affect the resource whose conservation is identified as a goal in the park's general management plan or other park planning documents.

According to the National Park Service's SUM06 ozone index maps for year 2000, the ozone level for the recreation area 15–25 ppm/hr based on rural monitoring sites.

Impacts of Alternative A — Continue PWC Use under a Special NPS Regulation

Analysis. Under this alternative there would be no locational restrictions or changes in speed restrictions for personal watercraft. Based on data collected by NPS staff, PWC annual use is estimated to be 8,294 craft in 2002, increasing to 9,162 in 2012.

Table 34 presents the annual PWC emission loads and their impact levels for 2002 and 2012 under this alternative.

TABLE 34: AIR QUALITY RELATED IMPACTS FROM PWC EMISSIONS, ALTERNATIVE A

Air Quality Related Value (indicator)	Emission Level (tons/year)/ Local Ozone Data		Visibility Threshold / SUM06 Index Value		Impact Level	
	2002	2012	2002	2012	2002	2012
Visibility ($PM_{2.5}$)	3.2	2.7	No perceptible visibility impacts	No perceptible visibility impacts	Negligible	Negligible
Ozone injury to plants (injury symptoms and ozone monitoring data)	No park specific effects documented	No park specific effects anticipated	SUM06 index value: 19–25 ppm-hrs (rural monitoring sites for 2000)	SUM06 index value: less than or equal to 19–25 ppm-hrs (assumed to be no greater than in 2002)	Minor (see analysis)	Minor (see analysis)

SOURCE: NPS Air Resources Division for SUM06 values.

Impact levels for visibility in both 2002 and 2012 are predicted to be negligible, with $PM_{2.5}$ emissions less than 50 tons/year. The air quality impact level for ozone exposure would be minor adverse in 2002 and 2012. The SUM06 ozone data show ozone to be in the range of 19 to 25 ppm-hours, which indicates a possible moderate regional impact level; however, this value reflects emissions from all local and regional sources, and personal watercraft a very small amount. Local park conditions are therefore weighted more heavily in the analysis, and an overall minor impact level for air quality related values is predicted.

Cumulative Impacts. The cumulative impact analysis includes other motorized watercraft use, taking into consideration national use trends, as well as current and future emission levels. Cumulative emissions under alternative A are shown in Table 35.

TABLE 35: AIR QUALITY RELATED IMPACTS FROM PWC AND MOTORIZED BOAT EMISSIONS, ALTERNATIVE A

Air Quality Related Value (indicator)	Emission Level (tons/year)/ Local Ozone Data		Visibility Threshold / SUM06 Index Value		Impact Level	
	2002	2012	2002	2012	2002	2012
Visibility ($PM_{2.5}$)	6.8	6.6	No perceptible visibility impacts	No perceptible visibility impacts	Negligible	Negligible
Ozone injury to plants (injury symptoms and ozone monitoring data)	No park specific effects documented	Unknown, but not anticipated	SUM06 index value: 19–25 ppm-hrs (rural monitoring sites for 2000)	SUM06 index value: less than or equal to 19–25 ppm-hrs (assumed to be no greater than in 2002)	Minor (see analysis)	Minor (see analysis)

SOURCE: NPS Air Resources Division for SUM06 values.

There would be negligible impacts to visibility on a cumulative basis, as $PM_{2.5}$ emissions would be below 50 tons/year in 2002 and 2012. Current ozone exposure based on SUM06 ozone values is in the range of 19–25 ppm-hours. The SUM06 ozone maps show that ozone levels are concentrated in northeastern Texas and that ozone and its precursor chemicals are transported north into Oklahoma. No ozone injury symptoms have been identified. Overall cumulative impacts are predicted to be minor in 2002 and 2012.

Conclusion. Continuing PWC use would have negligible adverse impacts on visibility in both 2002 and 2012. There would be a minor adverse impact level from ozone exposure in 2002 and 2012. Overall impacts to air quality related values from PWC use would be minor in both 2002 and 2012.

On a cumulative basis there would be negligible visibility impacts and minor adverse impacts from ozone exposure in 2002 and 2012. Ambient elevated ozone levels in the area of Chickasaw appear to be primarily a result of ozone and its precursor pollutants being transported from northern Texas to southern Oklahoma and not a result of local conditions. Overall combined impacts to air quality related values are anticipated to be minor in both 2002 and 2012 when considered in the context of the regional setting.

This alternative would not result in an impairment of air quality related values.

Impacts of Alternative B — Continue PWC Use under a Special Regulation with Additional Management Prescriptions

Analysis. Under this alternative the annual number of personal watercraft using Chickasaw would be the same as alternative A (8,294 personal watercraft in 2002, increasing to 9,162 in 2012). PWC impact levels to air quality related values are shown in Table 36

TABLE 36: AIR QUALITY RELATED IMPACTS FROM PWC EMISSIONS, ALTERNATIVE B

Air Quality Related Value (indicator)	Emission Level (tons/year)/ Local Ozone Data		Visibility Threshold / SUM06 Index Value		Impact Level	
	2002	2012	2002	2012	2002	2012
Visibility ($PM_{2.5}$)	3.2	2.7	No perceptible visibility impacts	No perceptible visibility impacts	Negligible	Negligible
Ozone injury to plants (injury symptoms and ozone monitoring data)	No park-specific effects documented	No park-specific effects anticipated	SUM06 index value: 19–25 ppm-hrs (rural monitoring sites for 2000)	SUM06 index value: less than or equal to 19–25 ppm-hrs (assumed to be no greater than in 2002)	Minor (see analysis)	Minor (see analysis)

SOURCE: NPS Air Resources Division for SUM06 values.

The predicted emissions levels and impacts of continued PWC use to air quality related values would be the same as alternative A, based on annual emission rates. The visibility impact levels would be negligible in 2002 and 2012, and ozone injury impact levels would be minor in both years.

Cumulative Impacts. Cumulative emissions and impact levels to air quality related values from all motorized watercraft under alternative B would be similar to alternative A. Cumulative impact levels to air quality related values are shown in Table 37.

TABLE 37: AIR QUALITY RELATED IMPACTS FROM PWC AND MOTORIZED BOAT EMISSIONS, ALTERNATIVE B

Air Quality Related Value (indicator)	Emission Level (tons/year)/ Local Ozone Data		Visibility Threshold / SUM06 Index Value		Impact Level	
	2002	2012	2002	2012	2002	2012
Visibility ($PM_{2.5}$)	6.8	6.6	No perceptible visibility impacts	No perceptible visibility impacts	Negligible	Negligible
Ozone injury to plants (injury symptoms and ozone monitoring data)	No park specific effects documented	Unknown	SUM06 index value: 19–25 ppm-hrs (rural monitoring sites for 2000)	SUM06 index value: less than or equal to 19–25 ppm-hrs (assumed to be no greater than in 2002)	Minor (see analysis)	Minor (see analysis)

SOURCE: NPS Air Resources Division for SUM06 values.

Visibility impact levels would be negligible in 2002 and 2012, with $PM_{2.5}$ emissions below 50 tons/year. The impact levels to plants from ozone exposure would be minor in 2002 and 2012. The SUM06 ozone values of 19–25 ppm-hours for the southern Oklahoma/Chickasaw area indicate that sources outside of the unit are elevating ambient ozone levels in the area of Chickasaw. The overall impact level to air quality related values from all motorized uses at Chickasaw would be minor in both 2002 and 2012.

Conclusion. Alternative B would have negligible adverse impacts on visibility and a minor adverse impact from ozone exposure in 2002 and 2012. Overall impacts to air quality related values from PWC use would be minor in both 2002 and 2012.

On a cumulative basis impacts on visibility would be negligible, and impacts related to ozone exposure would be minor. SUM06 ozone monitoring data indicate that Chickasaw is influenced by the transport of ozone and its precursor pollutants from northern Texas. Overall combined impacts to air quality related values are anticipated to be minor in both 2002 and 2012 when considered in the context of the regional setting.

This alternative would not result in an impairment of air quality related values.

Impacts of Alternative C — Continue PWC Use but Limit Area of Use and Implement Other Restrictions

Analysis. Under this alternative the annual number of personal watercraft using Chickasaw would follow the same trends as alternatives A and B, increasing from 8,294 watercraft in 2002 to 9,162 in 2012. PWC use would be restricted to the body and some arms of Lake of the Arbuckles. The current no-wake zones (with associated 5 mph speed restrictions) would be expanded, resulting in additional reductions in emissions due to reduced overall engine load in the recreation area compared to alternative A or B. Impact levels are shown in Table 38.

TABLE 38: AIR QUALITY RELATED IMPACTS FROM PWC EMISSIONS, ALTERNATIVE C

Air Quality Related Value (indicator)	Emission Level (tons/year)/ Local Ozone Data		Visibility Threshold / SUM06 Index Value		Impact Level	
	2002	2012	2002	2012	2002	2012
Visibility ($PM_{2.5}$)	2.3	1.4	No perceptible visibility impacts	No perceptible visibility impacts	Negligible	Negligible
Ozone injury to plants (injury symptoms and ozone monitoring data)	No park specific effects documented	Unknown	SUM06 index value: 19–25 ppm-hrs (rural monitoring sites for 2000)	SUM06 index value: less than or equal to 19–25 ppm-hrs (assumed to be no greater than in 2002)	Minor (see analysis)	Minor (see analysis)

SOURCE: NPS Air Resources Division for SUM06 values.

Visibility impact levels related to PWC use would be negligible in 2002 and 2012 because $PM_{2.5}$ emission levels would be well below 50 tons/year. Ozone injury impact levels would be minor throughout the period.

Cumulative Impacts. Cumulative emissions and impacts of all motorized watercraft under alternative C would be slightly less then under alternative A due to expanded no-wake zones. Cumulative impact levels are shown in Table 39:

TABLE 39: AIR QUALITY RELATED IMPACTS FROM PWC AND MOTORIZED BOAT EMISSIONS, ALTERNATIVE C

Air Quality Related Value (indicator)	Emission Level (tons/year)/ Local Ozone Data		Visibility Threshold / SUM06 Index Value		Impact Level	
	2002	2012	2002	2012	2002	2012
Visibility ($PM_{2.5}$)	5.5	4.9	No perceptible visibility impacts	No perceptible visibility impacts	Negligible	Negligible
Ozone injury to plants (injury symptoms and ozone monitoring data)	No park specific effects documented	Unknown	SUM06 index value: 19–25 ppm-hrs (rural monitoring sites for 2000)	SUM06 index value: less than or equal to 19–25 ppm-hrs (assumed to be no greater than in 2002)	Minor (see analysis)	Minor (see analysis)

SOURCE: NPS Air Resources Division for SUM06 values.

Visibility impact levels would be negligible in 2002 and 2012, as $PM_{2.5}$ emissions would be below 50 tons/year. Ozone injury impact levels would be minor in 2002 and 2012 based on lack of injury symptoms and SUM06 ozone values. The SUM06 ozone values of 19–25 ppm-hours for the southern Oklahoma/Chickasaw area indicate that sources outside of the unit are elevating ambient ozone levels. The overall impact level to air quality related values from all motorized uses at Chickasaw would be minor in both 2002 and 2012.

Conclusion. Under alternative C impacts to visibility related to PWC use would be negligible in 2002 and 2012. There would be a minor adverse impact from ozone exposure in 2002 and 2012 from PWC use alone. Overall impacts to air quality related values from PWC use would be minor in both 2002 and 2012.

On a cumulative basis, there would be negligible impact levels to visibility in both 2002 and 2012 and a minor impact from ozone exposure. SUM06 ozone monitoring data indicate that Chickasaw is influenced by the transport of ozone and its precursor pollutants from northern Texas. Overall combined impacts to air quality related values are anticipated to be minor in both 2002 and 2012 when considered in the context of the regional setting.

This alternative would not result in an impairment of air quality related values.

Impacts of the No-Action Alternative — No PWC Use

Analysis. Banning PWC use would result in a beneficial impact to air quality related values, with no PWC-related emissions.

Cumulative Impacts. While PWC use would no longer be allowed within the unit, other motorized watercraft would operate at the use levels assumed for alternative A, and the area would continue to be influenced by other sources of $PM_{2.5}$ and ozone. Cumulative impacts to air quality related values are shown in Table 40.

TABLE 40: AIR QUALITY RELATED IMPACTS FROM PWC AND MOTORIZED BOAT EMISSIONS, NO-ACTION ALTERNATIVE

Air Quality Related Value (indicator)	Emission Level (tons/year)/ Local Ozone Data		Visibility Threshold / SUM06 Index Value		Impact Level	
	2002	2012	2002	2012	2002	2012
Visibility ($PM_{2.5}$)	3.6	3.9	No perceptible visibility impacts	No perceptible visibility impacts	Negligible	Negligible
Ozone injury to plants (injury symptoms and ozone monitoring data)	No park specific effects documented	Unknown	SUM06 index value: 19–25 ppm-hrs (rural monitoring sites for 2000)	SUM06 index value: less than or equal to 19–25 ppm-hrs (assumed to be no greater than in 2002)	Minor (see analysis)	Minor (see analysis)

SOURCE: NPS Air Resources Division for SUM06 values.

Visibility impact levels would be negligible in both 2002 and 2012, with no emissions from personal watercraft. The ozone impact levels from air emissions of all activities under the no-action alternative for both 2002 and 2012 would be minor, based on current air quality SUM06 data.

Conclusion. Banning PWC use would result in beneficial impacts on air quality related values.

On a cumulative basis there would be a negligible impact to visibility and a minor impact from ozone exposure in 2002 and 2012 when all motorized watercraft and other ozone sources are considered. SUM06 ozone monitoring data indicate that Chickasaw is influenced by the transport of ozone and its precursor pollutants from northern Texas, and that banning PWC use would not likely affect ambient ozone levels. Overall combined impacts to air quality related values are anticipated to be minor in both 2002 and 2012 when considered in the context of the regional setting.

This alternative would not result in an impairment of air quality related values.

SOUNDSCAPES

The primary soundscape issue relative to PWC use is that other visitors may perceive the sound made by personal watercraft as an intrusion or nuisance, thereby disrupting their experiences. This disruption is generally short term because personal watercraft travel along the shore to outlying areas. However, as PWC use increases and concentrates at beach areas, related noise becomes more of an issue, particularly during certain times of the day. Additionally, visitor sensitivity to PWC noise varies from anglers (more sensitive) to swimmers at popular beaches (less sensitive).

GUIDING REGULATIONS AND POLICIES

The national park system includes some of the quietest places in North America, as well as a rich variety of sounds intrinsic to park environments. These intrinsic sounds are recognized and valued as a park resource in keeping with the NPS mission (*Management Policies 2001,* sec. 1.4.6), and are referred to as the park's natural soundscape. The natural soundscape, sometimes called natural quiet, is the aggregate of all the natural sounds that occur in parks, absent human-caused sound, together with the physical capacity for transmitting the natural sounds (*Management Policies 2001,* sec. 4.9). It includes all of the sounds of nature, including such "non-quiet" sounds as birds calling, waterfalls, thunder, and waves breaking against the shore. Some natural sounds are also part of the biological or other physical resource components of parks (e.g., animal communication, sounds produced by physical processes such as wind in trees, thunder, running water).

NPS policy requires the restoration of degraded soundscapes to the natural condition whenever possible, and the protection of natural soundscapes from degradation due to noise (undesirable human-caused sound) (*Management Policies 2001,* sec. 4.9). The National Park Service is specifically directed to "take action to prevent or minimize all noise that, through frequency, magnitude, or duration, adversely affects the natural soundscape or other park resources or values, or that exceeds levels that have been identified as being acceptable to, or appropriate for, visitor uses at the sites being monitored" (*Management Policies 2001,* sec. 4.9). Overriding all of this is the fundamental purpose of the national park system, established in law (e.g., 16 USC 1 et seq.), which is to conserve park resources and values (*Management Policies 2001*. sec. 1.4.3). NPS managers must always seek ways to avoid, or to minimize to the greatest degree practicable, adverse impacts on park resources and values (*Management Policies 2001,* sec 1.4.3).

Noise can adversely affect park resources, including but not limited to natural soundscapes. It can directly impact them, for example by modifying or intruding upon the natural soundscape. It can also indirectly impact resources, for example by interfering with sounds important for animal communication, navigation, mating, nurturing, predation, and foraging functions.

Noise can also adversely impact park visitor experiences. The term "visitor experience" can be defined as the opportunity for visitors to experience a park's resources and values in a manner appropriate to the park's purpose and significance, and appropriate to the resource protection goals for a specific area or management zone within that park. In other words, visitor experience is primarily a resource-based opportunity appropriate to a given park or area within a park, rather than a visitor-based desire. Noise impacts to visitor experience can be especially adverse when management objectives for visitor experience include solitude, serenity, tranquility, contemplation, or a completely natural or historical environment. Management objectives (also called desired conditions) for resource protection and visitor experience are derived through well-established public planning processes from law, policy, regulations, and management direction applicable to the entire national park system and to each specific park unit.

Visitor uses of parks will only be allowed if they are appropriate to the purpose for which a park was established, and if they can be sustained without causing unacceptable impacts to park resources or values (*Management Policies 2001,* sec. 8.1 and 8.2). While the fundamental purpose of all parks also includes providing for the "enjoyment" of park resources and values by the people of the United States, enjoyment can only be provided in ways that leave the resources and values unimpaired for the enjoyment of future generations (*Management Policies 2001,* sec. 1.4.3). Unless mandated by statute, the National Park Service will not allow visitors to conduct activities that, among other things, unreasonably interfere with "the atmosphere of peace and tranquility, or the natural soundscape maintained in wilderness and natural, historic, or commemorative locations within the park" (*Management Policies 2001,* sec. 8.2). While many visitor activities are allowed or even encouraged in parks consistent with the above policies, virtually all

visitor activities are limited or restricted in some way (e.g., through carrying capacity determinations, implementation plans, or visitor use management plans), and on a park or area specific basis, some visitor activities are not allowed at all.

The degree to which a given activity (e.g., PWC use) is consistent with, or moves the condition of a resource or a visitor experience toward or away from a desired condition, is one measure of the impact of the activity.

The federal regulation pertaining to noise abatement for boating and water use activities (36 CFR 3.7) prohibits operating a vessel on inland waters "so as to exceed a noise level of 82 decibels measured at a distance of 82 feet (25 meters) from the vessel" and specifies that testing procedures to determine such noise levels should be in accordance with or exceed those established by the Society of Automotive Engineers (SAE) in "Exterior Sound Level Measurement Procedure for Pleasure Motorboats" (J34). This SAE procedure specifies that sound level measurements be taken 25 meters perpendicular to the line of travel of the vessel at full throttle (SAE 2001). It is important to note that this NPS regulation and the SAE procedure were developed for enforcement purposes, not impact assessment purposes. The level in the regulation does not imply that there are no impacts to park resources or visitor experiences at levels below 82 dB; it just indicates that noise levels from vessels legally operating on NPS waters will be no "louder" than 82 dB. As explained elsewhere in this document, a single decibel value does not provide much information for impact assessment purposes.

In addition to NPS policies, Oklahoma has adopted legislation that regulates PWC operation. The following elements of Oklahoma PWC regulations may have impacts on recreation area soundscapes:

- Timing restrictions — Personal watercraft can not be used between sunset and sunrise.
- Location restrictions — Personal watercraft cannot operate within 150 feet of any persons, dock, buoy, bridge, or any other prohibitive structure at a speed greater than idle or slow steerageway speed.
- No person shall operate vessels at speeds in excess of the speed limits established for those waters.
- All vessels must be equipped with a muffler system, in good working order, which cannot be modified to increase noise levels.

METHODOLOGY AND ASSUMPTIONS

The methodology used to assess PWC-related noise impacts in this document is consistent with NPS *Management Policies 2001, Director's Order #47: Soundscape Preservation and Noise Management,* and the methodology being developed for the reference manual for DO #47 (NPS 2000b). Specific factors at Chickasaw related to context, time, and intensity are discussed below and are then integrated into a discussion of the impact thresholds used in this analysis.

Context: Existing background noise levels at Chickasaw are influenced by wave action, wind, visitor activities, other boats, and light automobile traffic. The soundscape at high-use areas such as The Point and especially the Buckhorn picnic and campground areas is influenced by visitor activities, including PWC and other motorboat use, during the busy summer months. In other areas of Lake of the Arbuckles, especially in the arms of the lake in or near the no-wake zones, natural sounds are evident.

Time Factors: *Time Periods of Interest* — PWC use at Chickasaw occurs primarily from April to October, although a reduced level of use occurs in all months. On a weekly basis, weekends and

holiday periods see the greatest numbers of PWC users, with weekday use averaging about 30% of the weekend use. On a daily basis, use peaks during midday. Use generally stops during periods of inclement weather (e.g., cold, and thunderstorms).

Time periods of greater sensitivity to noise impacts include sunset, sunrise, and night time when visitors may be in camp, and when wildlife may be more active.

Duration and Frequency of Occurrence of Noise Impacts — In areas of concentrated PWC use, noise from personal watercraft (and other boat types) can be present intermittently from early morning to sunset. In areas of lower use, noise from personal watercraft (and other boat types) can be occasional, usually lasting a few minutes. On peak weekend days, an average of 66 personal watercraft are used for four hours each; an average of 20 personal watercraft are used on weekdays during the same high-use period.

Intensity: Some literature states that all recently manufactured watercraft emit fewer than 80 dB at 50 feet from the vessel, while other sources attribute levels as high as 102 dB without specifying distance.

Noise limits established by the National Park Service are 82 dB at 82 feet. PWC noise travels in relationship to the speed of the craft, the distance from shoreline, and other influences. Outdoor noise levels usually decrease with increasing distance from the source because of geometrical spreading of the noise over a bigger surface and absorption of the noise by the atmosphere and the ground (Bruer and Kjaer 2002). According to Komanoff and Shaw (2000), PWC noise dissipates by 5 dBA across water for each doubling of distance from a 20-foot circle around the source and by 6 dBA across land. A PWC engine in the water produces 80 dB of sound within a 20-foot radius, and 73 dB within a 50-foot radius (Komanoff and Shaw 2000). This is close to estimates provided by the Personal Watercraft Industry Association (PWIA 2002), which state that one PWC operating 50 feet from an onshore observer is heard at 71 dBA, and two would be heard at 74 dBA.

The National Park Service contracted for noise measurements of personal watercraft and other motorized vessels in 2001 at Glen Canyon National Recreation Area (Harris Miller Miller & Hanson, Inc. 2002). The results show that maximum PWC noise levels at 82 feet (25 meters) ranged from 68 to 76 dBA. Noise levels for other motorboat types measured during that study ranged from 65 to 86 dBA at 82 feet. However, PWC-generated noise may be more disturbing due to rapid changes in acceleration and direction of noise than noise from a constant source at 90 dB (US EPA 1974, cited in Izaak Walton League 1999).

Vegetation can also decrease noise. According to the U.S. Department of Transportation (FHWA 2000), vegetation must be so high, wide, and dense that it cannot be seen through, and must be at least 61 meters (186 feet) wide to reduce noise by 10 dB.

In response to public complaints, the PWC industry has employed new technologies to reduce sound by about 50% to 70% on 1999 and newer models (Sea-Doo 2000; Hayes 2002). Additionally, by 2006 the EPA requirements will reduce PWC noise, in association with improvements to engine technology (US EPA 1996b).

Context, time, and intensity together determine the level of impact for an activity. For example, noise for a certain period and intensity would be a greater impact in a highly sensitive context, and a given intensity would be a greater impact if it occurred more often, or for longer duration. It is usually necessary to evaluate all three factors together to determine the level of noise impact. In some cases an analysis of one or more factors may indicate one impact level, while an analysis of another factor may indicate a different

impact level, according to the criteria below. In such cases, best professional judgment based on a documented rationale must be used to determine which impact level best applies to the situation being evaluated.

PWC noise travels in relationship to the speed of the craft, the distance from shoreline, and other influences. To estimate the relative impacts of noise from PWC use, the following methodology was applied:

1. National literature was used to estimate the average decibel levels of personal watercraft.
2. Areas of shoreline use by other visitors were identified in relation to where personal watercraft launch and operate offshore. Personal observation from park staff and monthly use reports were used to identify these areas, as well as determine the number of personal watercraft and timeframes of use.
3. Other considerations, such as topography and prevailing winds, were then used to identify areas where PWC noise levels could be exacerbated or minimized.

Sound levels generated by motorized craft using the recreation area are expected to affect recreational users differently. For example, visitors participating in less sound-intrusive activities such as camping would likely be more adversely affected by PWC noise than another PWC or motorboat user. Therefore, impacts to soundscape must take into account the effect of noise levels on different types of recreational users within the impact analysis area. The following is a list of other considerations for evaluating sound impacts:

- The average number of personal watercraft on high use weekends is 66 per day, which under present trends is expected to increase to 73 by 2012. On very high use days that number can reach 135 (2002) to 148 (2012) per day. These watercraft are dispersed over a 35-mile shoreline and would be in operation for approximately four hours per day on average.
- Personal watercraft commonly operate farther than 150 feet from the shoreline; the farther from shore, the lower the noise level to shoreline visitors.
- Noise levels within no-wake zones are very low and occur for short duration.
- Ambient noise levels at most locations include wind, waves, other visitors, and other motorboats. At Chickasaw, PWC use can be up to 30% of total watercraft during the peak PWC use season, generally April to October.

IMPACT ANALYSIS AREA

The impact analysis area for soundscapes is related to the area of PWC use and the distance that PWC noise travels. For the existing condition, PWC operate in all areas of Lake of the Arbuckles except for the exclusion zones near the Goddard Youth Camp, the picnic area at the end of The Point Road, and two areas near the Buckhorn picnic and camping area. PWC noise can travel inland and is expected to dissipate significantly within 0.75 mile of the source. Thus, the impact analysis area for soundscapes is the lake area, the shoreline, and the 0.75-mile inland shore area.

IMPACT TO VISITORS FROM NOISE GENERATED BY PERSONAL WATERCRAFT

After estimating the number of personal watercraft, the range of relative noise generated by them, and the potential areas where noise concentrations and effects on other visitors may be of concern, the following thresholds were used as indicators of the magnitude of impact for each of the PWC management alternatives:

Negligible: Natural sounds would prevail; motorized noise would be very infrequent or absent, mostly immeasurable.

Minor: Natural sounds would predominate in areas where management objectives call for natural processes to predominate, with motorized noise infrequent at low levels. In areas where motorized noise is consistent with park purpose and objectives, motorized noise could be heard frequently throughout the day at moderate levels, or infrequently at higher levels, and natural sounds could be heard occasionally.

Moderate: In areas where management objectives call for natural processes to predominate, natural sounds would predominate, but motorized noise could occasionally be present at low to moderate levels. In areas where motorized noise is consistent with park purpose and objectives, motorized noise would predominate during daylight hours and would not be overly disruptive to noise-sensitive visitor activities in the area; in such areas, natural sounds could still be heard occasionally.

Major: In areas where management objectives call for natural processes to predominate, natural sounds would be impacted by human noise sources frequently or for extended periods of time at moderate intensity levels (but no more than occasionally at high levels), and in a minority of the area. In areas where motorized noise is consistent with park purpose and zoning, the natural soundscape would be impacted most of the day by motorized noise at low to moderate intensity levels, or more than occasionally at high levels; motorized noise would disrupt conversation for long periods of time and/or make enjoyment of other activities in the area difficult; natural sounds would rarely be heard during the day.

Impairment: The level of noise associated with PWC use would be heard consistently and would be readily perceived by other visitors throughout the day, especially in areas where such noise would potentially conflict with the intended use of that area. In addition, these adverse, major impacts to park resources and values would

contribute to deterioration of the park's soundscape to the extent that the park's purpose could not be fulfilled as established in its enabling legislation;

affect resources key to the park's natural or cultural integrity or opportunities for enjoyment; or

affect the resource whose conservation is identified as a goal in the park's general management plan or other park planning documents.

Impacts of Alternative A — Continue PWC Use under a Special NPS Regulation

Analysis. As stated in the assumptions, weekend and holiday period PWC use levels are projected to range from 66 to 73 craft per day during the typical high use season over the next 10 years. The distribution of personal watercraft under this alternative would continue the same pattern of use that currently exists. Due the size of the lake, PWC users generally distribute themselves throughout the lake, although the density of personal watercraft can be higher near launch areas and shoreline use areas, especially near the Buckhorn developed area. This is due to the way that personal watercraft are used by a group of

visitors at the park. Typically, several people use a machine and take turns riding, returning to the area where the group is picnicking/camping to rest or switch riders. From park staff observations, PWC users generally run at higher speeds (and higher noise levels) after they have left the launch or picnic/camping area and have gotten out into open water.

PWC users are supposed to operate at no-wake speeds within 150 feet of all persons and shoreline areas near campgrounds. However, there are picnic and other shoreline use areas where personal watercraft can be operated closer to shore, if no swimmers are present. The primary shoreline use areas are the facilities at Guy Sandy, The Point, and the Buckhorn developed area, in ascending order of users. Picnickers or swimmers are exposed to noise when personal watercraft enter or leave the shore area (if allowed), or when several craft are operating at high speeds in the vicinity. The impact from one personal watercraft coming into the shore area depends on how soon the operator slows down and at what speed he or she approaches the shoreline. However, most PWC users approaching shore slow down sufficiently so that noise is less than 82 dBA at 82 feet. One personal watercraft operating at 50 feet from shore would generate noise levels of approximately 74 dBA to a shoreline observer; two watercraft would generate approximately 76 dBA. Also, some four-stroke models are reported to be quieter than their two-stroke counterparts (Sea-Doo 2001b; Yamaha Motor 2001); some reports use 5 dBA as the reduction in noise levels that can be obtained with the new equipment (Komanoff and Shaw 2000). Over the long term, the use of new PWC models would help lessen noise levels.

In other visitor use areas of the park, such as the Travertine Nature Center and hiking trails, or Veterans Lake, PWC noise has not been a major concern due to the distance of those facilities from Lake of the Arbuckles and the attenuating effect of topography and vegetation.

Overall, noise levels from personal watercraft could have minor to moderate adverse impacts at certain locations along the shore on days when PWC use was relatively heavy. Minor impacts would occur where use was infrequent and distanced from other park users, for example, as PWC users operated far from shore. Moderate impacts could occur from concentrated PWC use in one area, particularly near the shoreline at the Buckhorn recreation areas, where motorized noise could predominate on busy summer weekends. On the highest PWC use days of the year, such as a Saturday on the Fourth of July holiday weekend, motorized noise could predominate for most of the day at the Buckhorn developed area. While noise levels may be bothersome for some, most visitors at Chickasaw on a busy holiday weekend expect to hear motorized noises, and PWC and other motorized use is consistent with park purpose of supplying visitors with water-based recreational opportunities.

Noise impacts also occur at other areas within the lake environment other than the high-use areas such as The Point and the Buckhorn developed areas. These impacts occur where PWC use would conflict with other quieter uses, such as fishing, or people on shore or other craft who may be enjoying natural sounds or watching wildlife. These activities may occur more often early in the morning or early evening when fishing is more popular, and when natural sounds and wildlife are more evident. Park staff occasionally receive complaints from anglers about PWC disturbance. In general, the impact of PWC use on those seeking a quieter experience would most likely be short term and minor because PWC users are not extremely active in early morning hours, because use would not be constant throughout the day, and because enjoyment of the typical visitor activities in the area would not be compromised. Overall, this alternative would result in a net minor to moderate impact on the soundscape of Chickasaw.

Cumulative Impacts. Other noise sources in Chickasaw include natural sounds such as waves or wind, other boats operating on Lake of the Arbuckles, and other visitor activities. Boating activities in the lake are capable of generating noise levels as high as those from personal watercraft due to the number of motorboats (70% to 80% of total motorized use), their area of operation (which is similar to the PWC use

area), and noise characteristics of motorboats, which can operate at higher dBA than personal watercraft. While many motorboats can generate higher sound levels than personal watercraft, they are generally not perceived to be as annoying due to their more typical steady rate of speed and direction.

The cumulative effect of PWC and boating noise would continue to have a minor to moderate adverse impact because it would be heard occasionally throughout the day. Impacts are generally short term, since noise would usually be of limited duration, except on very busy holidays when all motorized noise and other human-caused sounds could predominate for most of the day at high-use, nearshore recreation areas such as The Point and the Buckhorn developed area.

Other visitors would also contribute to the soundscape, including beach users, picnickers, and campers. However, these sounds are considered more acceptable and compatible with typical uses within the national recreation area. Visitor noise has a negligible adverse effect on the soundscape at Chickasaw. Impacts are short term, since noise would usually be present for limited duration.

Conclusion. PWC noise would continue to have minor to moderate, temporary, adverse impacts over the short and long term at most locations on Lake of the Arbuckles and the immediate surrounding area. Impact levels would be related to the number of personal watercraft operating, as well as the sensitivity of other visitors. Over the long term PWC noise levels would be reduced with the introduction of newer engine technologies.

Cumulative noise impacts from personal watercraft, motorboats, and other visitors would be minor to moderate because these sounds would be heard occasionally throughout the day, and these sounds could predominate on busy days during the high-use season.

This alternative would not result in an impairment of the park's soundscape.

Impacts of Alternative B — Continue PWC Use under a Special NPS Regulation with Management Restrictions

Analysis. Under alternative B PWC use areas would remain the same as alternative A, except a 150-foot-wide no-wake zone would be designated around the Buckhorn developed area. A voluntary user group that would educate PWC users on the potential noise impacts they may have on other park visitors could help to some extent, but its effectiveness would be difficult to measure. Noise impacts of one or more personal watercraft operating in the vicinity of other visitors would still occur.

Overall, alternative B would result in a small reduction in noise levels experienced by other park visitors, particularly at the Buckhorn developed area. The types and levels of adverse impacts to the soundscape of Chickasaw would be generally the same as for alternative A, including minor, short- and long-term, adverse impacts when use is occasional and distanced from other park users, and moderate, short- and long-term, adverse impacts when use is concentrated in one area, particularly near Buckhorn and The Point. At these locations noise could be heard occasionally on weekdays, but could predominate during high-use holiday periods. As described under alternative A, some four-stroke models are reported to be quieter than their two-stroke counterparts (Sea-Doo 2001b; Yamaha Motor 2001); some reports use 5 dBA as the reduction in noise levels that can be obtained with the new equipment (Komanoff and Shaw 2000). Over the long term, the use of new PWC models would help lessen noise levels.

Overall, this alternative would result in minor to moderate, short- and long-term, adverse impacts on the soundscape of Chickasaw. On high-use days, motorized noise could predominate for most of the day.

Most visitors during these high-use periods expect to hear motorized craft during the day, as the lake is known by the mostly local and regional users for providing this type of recreational opportunity

Cumulative Impacts. Impact types and overall threshold levels would be the same as alternative A, although there would be some slight differences. Expanding the no-wake zone around the Buckhorn developed area would have the effect of lowering noise levels, although PWC noise could still occasionally predominate the soundscape during high-use periods.

Other noise sources at Chickasaw include natural sounds such as waves or wind, other boats operating on Lake of the Arbuckles, and other visitor activities. Boating activities in the lake are capable of generating noise levels as high as personal watercraft because of the number of motorboats (70% to 80% of total motorized use), their area of operation (similar to personal watercraft), and noise characteristics of motorboats, which can operate at higher dBA than personal watercraft. While many motorboats can generate higher sound levels than PWC, they are generally not perceived to be as annoying due to their more typical steady rate of speed and direction.

Conclusion. PWC noise would continue to have minor to moderate, temporary, adverse impacts over the short and long term at most locations on Lake of the Arbuckles and the immediate surrounding area. Impact levels would be related to the number of personal watercraft operating, as well as the sensitivity of other visitors. Expanding the no-wake zone around the Buckhorn developed area would have a beneficial effect, although it would not change overall impact types or threshold levels. Over the long term PWC noise levels would be reduced with the introduction of newer engine technologies.

Cumulative noise impacts from personal watercraft, motorboats, and other visitors would be minor to moderate because these sounds would be heard occasionally throughout the day, and they could predominate on busy days during the high-use season.

This alternative would not result in an impairment of the park's soundscape.

Impacts of Alternative C — Continue PWC Use under a Special NPS Regulation but Limit Areas of Use and Implement Other Restrictions

Analysis. Alternative C includes several management actions that could affect the soundscape at Chickasaw. PWC use would be restricted in the expanded no-wake zone at Guy Sandy and Rock Creek. PWC use would also be restricted within 150 feet of all shorelines except for certain access areas (such as launch sites and designated mooring areas). A no-wake zone would be established around the Buckhorn use area, and the no-wake zone in the Buckhorn Creek arm of the lake would be expanded (see the Alternative C map). This alternative would also require personal watercraft using Lake of the Arbuckles to meet the EPA 2006 emission standards in 2005. Alternative C would have two options for time restrictions: either allow PWC use only between 9 A.M. and 5 P.M., or limit PWC use to weekends and holidays.

Because alternative C would require PWC users on Lake of the Arbuckles to meet the EPA 2006 emission standards in 2005, overall PWC noise levels would be reduced. Newer machines that meet the more stringent emission standards are also quieter; some reports use 5 dBA as the reduction in noise levels that can be obtained with the new equipment (Komanoff and Shaw 2000). However, PWC-generated noise could still predominate if there were large numbers of users in a relatively small area.

Restricting use in the Guy Sandy and Rock Creek no-wake zones would have a beneficial impact on the soundscape in those areas. Although these are not high use shoreline areas for other visitors, anglers, and passive recreationists who may use the lake in those areas would benefit. Establishing a 150-foot

restricted area around the perimeter of the lake (except for designated access areas) would also reduce noise levels at receptor points. Distance from the source of noise plays an important role in sound levels at any given point. Typically one can expect a 5 dBA reduction sound levels with each doubling of distance (Komanoff and Shaw 2000). For example, in situations where PWC users can currently operate at full throttle 40 feet from shore, one would experience almost a 10 dBA reduction in noise with the 150-foot restriction. Although on busy summer weekends, and especially holiday weekends, PWC noise would still be predominant in the soundscape, the intensity level would be reduced. The positive effect of this would depend on how many personal watercraft were operating in the area. Near high-use shoreline areas, such as the Buckhorn developed area where PWC users could congregate, the soundscape would still be influenced by PWC noise. Expanding the no-wake zone around the Buckhorn developed area would also reduce the noise heard by visitors onshore because noise levels drop when the machines operate at no-wake speeds, and the slow speeds typically prevent the machine from coming out of the water, which exacerbates the noise effect.

Allowing PWC use only from 9 A.M. to 5 P.M. would prevent PWC noise impacts during quieter times of day. For example, early morning and early evening typically are times when fishing activity is highest and when wildlife may be more active. It is also when campers and other park users enjoy relative quiet and being able to hear natural sounds. Although PWC use is generally not high in early morning hours, it can be high after 5 P.M. in the summer. Alternatively, weekday restrictions would also create a quiet period during the week for fishing, wildlife viewing, and other park activities, although these beneficial effects would not occur during higher use periods, when noise from personal watercraft would likely cause the most impact.

Overall, alternative C would result in reduced PWC noise levels for park visitors, with most of the beneficial effects in the areas where PWC use would be prohibited. Types of impacts to the soundscape of Chickasaw would be generally the same as for alternative A. Minor, short- and long-term, adverse impacts would occur when use was occasional and distanced from other park activities; and moderate adverse impacts would occur when use was concentrated in one area, particularly near the Buckhorn developed area and The Point. On very high-use days, PWC noise could predominate for most of the day. Establishing a 150-foot no-wake zone all along the shoreline could reduce this impact to minor levels, depending on compliance with the no-wake zone and the number of PWC users operating in the area. Restrictions under alternative C would reduce the amount of time impacts would reach the moderate level, staying most of the time in the minor category, especially the 9 A.M. to 5 P.M. restriction. Impact levels would be negligible to minor in the upper arms where use was prohibited.

Cumulative Impacts. Impact types and overall threshold levels would be the same as alternative B, although impacts would stay in the minor category (as opposed to moderate) more often than under either alternative A or B. Requiring the use of personal watercraft that would meet the EPA emission standards would result in lower decibel levels experienced by anglers and onshore visitors, and longer periods when PWC noise would not be heard by park visitors.

Other boating activities in the lake are capable of generating noise levels as high as personal watercraft due to the number of motorboats (70% to 80% of total motorized use), their area of operation, and noise characteristics of motorboats. Although many motorboats can generate higher sound levels than personal watercraft, they are generally not perceived to be as annoying due to their more typical steady rate of speed and direction. The beneficial effect of quieter operating personal watercraft, restricted use areas and times of operation, could be somewhat negated by the noise of other motorboats, which constitute 70% or more of total watercraft on the lake. However, the constant noise of boats is often perceived as less disturbing than that from personal watercraft.

Conclusion. PWC noise would continue to have minor, temporary, adverse impacts over the short and long term at many locations on Lake of the Arbuckles and the immediate surrounding area, with potentially moderate impacts at some high-use areas. Restrictions in alternative C would produce a beneficial effect on the soundscape of the park, reducing noise levels and periods of potential impact.

Cumulative noise impacts from personal watercraft, motorboats, and other visitors would be minor to moderate because these sounds would be heard occasionally throughout the day, and they could predominate on busy days during the high-use season. Impacts would more often be minor rather than moderate.

Alternative C would not result in an impairment of the park's soundscape.

Impacts of the No-Action Alternative — No PWC Use

Analysis. Banning PWC use, which comprises 20%–30% of total motorized use on high-use days, would result in a quieter environment for anglers, campers, and other park visitors, a beneficial impact for these users.

Cumulative Impacts. Cumulative impacts would be similar to the other alternatives, since other motorized boating activities would continue to create noise impacts throughout the day and in many locations on the lake. However, eliminating PWC use would reduce the level of noise on and near the lake.

Other uses also contribute to the area's soundscape, including sounds associated with swimming, picnicking, and camping. However, these sounds are considered more acceptable and compatible with other uses. Visitor noise has a negligible adverse effect on the natural soundscape at the park.

Conclusion. The overall decrease in noise due to the removal of personal watercraft would have a beneficial effect, especially on high-use days when PWC use comprises 20%–30% of total motorized use.

Cumulative noise impacts from motorboats and other visitor activities would be minor to moderate, but there would be no contribution from personal watercraft.

This alternative would not result in an impairment of the national recreation area's soundscape.

WILDLIFE AND WILDLIFE HABITAT

Some research suggests that PWC use affects wildlife by interrupting normal activities, causing alarm or flight, causing animals to avoid habitat, displacing habitat, and affecting reproductive success. This is thought to be caused by PWC speed, noise, and access to sensitive areas, especially in shallow water. Waterfowl and nesting birds are the most vulnerable to personal watercraft. Fleeing a disturbance created by a PWC user may force birds to abandon eggs during crucial embryo development stages, prevent nest defense from predators, and contribute to stress and associated behavior changes. Impacts to sensitive species, such as the bald eagle, are documented under "Threatened, Endangered, or Special Concern Species" (see page 114).

GUIDING REGULATIONS AND POLICIES

The NPS Organic Act, which directs parks to conserve wildlife unimpaired for future generations, is interpreted by the agency to mean that native animal life should be protected and perpetuated as part of

the park's natural ecosystem. Natural processes are relied on to control populations of native species to the greatest extent possible; otherwise they are protected from harvest, harassment, or harm by human activities. According to NPS *Management Policies 2001,* the restoration of native species is a high priority (sec. 4.1). Management goals for wildlife include maintaining components and processes of naturally evolving park ecosystems, including natural abundance, diversity, and the ecological integrity of plants and animals.

There are no additional federal, state, or local regulations or policies for wildlife and wildlife habitat at Chickasaw.

METHODOLOGY AND ASSUMPTIONS

Potential impacts to wildlife and wildlife habitat were evaluated on the pattern of PWC use in Lake of the Arbuckles, the nature of habitats and species present, and the professional judgment and observations of the project team and members of the park staff. Information on wildlife was obtained from NPS reports, the staff biologist, the U.S. Fish and Wildlife Service, the Oklahoma Department of Wildlife Conservation, and the Oklahoma Natural Heritage Inventory. To assess the magnitude of impacts from PWC use on wildlife, the following assumptions were made:

1. Most PWC users operate their craft in a lawful manner (i.e., 150 feet from most shoreline areas unless landing or launching).
2. Approximately 66 PWC users are on the lake during an average busy summer weekend day, for an average of four hours per day. PWC use is currently allowed from sunrise to sunset.
3. PWC use is projected to increase by 1% per year, with use increasing from 66 personal watercraft on a peak day in 2002 to 73 craft per day in 2012.

IMPACT ANALYSIS AREA

The impact analysis area includes Lake of the Arbuckles and surrounding lands extending 200 feet inland. This area is assumed to provide a more encompassing range for impact assessment based on the distance from the shoreline that wildlife could respond to PWC activity.

IMPACT OF PWC USE AND NOISE ON WILDLIFE AND HABITAT

The following thresholds were used to determine the magnitude of effects on wildlife and wildlife habitat:

Negligible: No wildlife species are present; no impacts or impacts with only temporary effects are expected.

Minor: Nonbreeding animals are present, but only in low numbers. Habitat is not critical for survival; other habitat is available nearby. Occasional flight responses by wildlife are expected, but without interference with feeding, reproduction, or other activities necessary for survival.

Moderate: Breeding animals are present; animals are present during particularly vulnerable life-stages such as migration or juvenile stages; mortality or interference with activities necessary for survival are expected on an occasional basis, but are not expected to threaten the continued existence of the species in the park.

Major: Breeding animals are present in relatively high numbers, and/or wildlife are present during particularly vulnerable life stages. Habitat targeted by PWC use or other actions have a

history of use by wildlife during critical periods and is somewhat limited. Mortality or other effects are expected on a regular basis and could threaten the continued survival of the species in the park.

Impairment: Some of the major impacts described above might be an impairment of park resources if their severity, duration, and timing resulted in the elimination of a native species or significant population declines in a native species. In addition, these adverse, major impacts to park resources and values would

contribute to deterioration of the park's wildlife resources and values to the extent that the park's purpose could not be fulfilled as established in its enabling legislation;

affect resources key to the park's natural or cultural integrity or opportunities for enjoyment; or

affect the resource whose conservation is identified as a goal in the park's general management plan or other park planning documents.

Impacts of Alternative A — Continue PWC Use under a Special NPS Regulation

Analysis. PWC use could affect wildlife wherever motorized vessels are allowed. Although PWC use is allowed throughout the lake, use is concentrated just outside the no-wake zones at launch areas (Buckhorn, The Point, and Guy Sandy) and around campgrounds and picnic areas. PWC use generally occurs from April through September, with the peak season between Memorial Day and Labor Day. However, there is limited PWC use year-round.

Wildlife typically stay near the shoreline due to habitat constraints, with some species present on the water surface 200 feet (or more) from shore. When a PWC user travels to the shoreline, the speed of the craft must be slowed to a no-wake speed, thus allowing any wildlife to easily move out of the way. No cases of PWC operators deliberately harassing or chasing birds or other wildlife on Lake of the Arbuckles have been documented, nor have collisions with waterfowl or wildlife.

Birds — With waterbirds, there can be considerable variation in flush distances among individuals and species in response to PWC noise, speed and wide horizontal spray (Rodgers and Schwikert 2002). Average flush distances from personal watercraft ranged from 64 to 162 feet (Rodgers and Schwikert 2002). The effect on wildlife foraging or resting would be temporary and short term, with the waterfowl returning after the disturbance abates. During the breeding season, there may be some temporary disturbance; however, since most PWC are not used in the early spring due to water and air temperatures, disturbances would be minimized. During rearing, PWC use could cause temporary effects when PWC users land along the shoreline. Impacts to wildlife and wildlife habitat would be minor at most locations.

Fish — As discussed in the "Water Quality" section, continued PWC use would create pollutant concentrations well below ecotoxicological benchmarks, so there would likely be no or negligible impacts on fish. Since the current water quality conditions have not been linked to the occurrence of cancer in gizzard shad in Lake of the Arbuckles, and PWC emissions have negligible effect on water quality, there would be no change to the current conditions under this alternative. There would also be no adverse impact from future PWC use because overall pollutant loads would be lower in 2012 due to the expected 50% reduction in PWC and outboard motor engine emission rates.

Reptiles and Amphibians — Impacts to reptiles and amphibians would most likely be where PWC or their users disrupted nesting or breeding sites, and these are not common in the high use areas of the lake. Some PWC users may venture away from the main public use areas and trample

shoreline areas, disturbing or destroying nests, egg masses, or individuals living on or in rock and debris along the shoreline. The impacts from these activities re expected to be temporary and minor at very localized areas.

Mammals — Impacts to mammals are expected to be negligible since there is little use of the shoreline by most mammals. Most of the species are either transient visitors from inland parts of the national recreation area or are already acclimated to human intrusion. Aquatic mammals such as beaver are mobile and avoid noise and disturbance associated with PWC use. Their breeding areas are typically in backwater areas not frequented by PWC. Adverse impacts would be negligible.

Continued use at Chickasaw would have negligible to no adverse effects on fish, and negligible to minor impacts on waterfowl and other wildlife. There would be no perceptible changes in wildlife populations or their habitat community structure. Impacts to fish, wildlife and habitats due to PWC use would be temporary and short term. The intensity or duration of impacts is not expected to increase substantially over the next 10 years, since PWC numbers would not increase substantially.

Cumulative Impacts. Potential cumulative effects on wildlife and wildlife habitat are related to activities that could occur in proximity to wildlife species. These activities include other visitors accessing the shoreline and other boaters traveling on the water or accessing the shoreline. Other types of boating activities account for approximately 50% of total boating activity during the summer months and 70% to 80% of total motorized watercraft annually. Wildlife routinely exhibit movement or flight response due to disturbance by powerboats. A study in Florida showed no substantial difference in flush distance between the rapid approach of PWC and non-PWC motorized vessels (Rodgers and Schwikert 2002).

Wildlife routinely exhibit movement or flight response due to visitor proximity. However, visitor interactions would not interfere with feeding, reproduction, or other activities necessary for the survival of wildlife species. Interactions between wildlife and human visitors would be limited because of the low abundance of wildlife within the high use areas and the dispersion of visitors along the shoreline. Shoreline use tends to be concentrated around developed facilities, where habitat characteristics are lacking compared to undeveloped shoreline. Overall, visitors (including PWC users) at Chickasaw would have negligible to minor adverse impacts to wildlife that are dispersed over a large area along the shoreline. All wildlife impacts would be temporary and short term.

Conclusion. Continued PWC use in all designated areas in Lake of the Arbuckles would result in negligible to minor, temporary impacts on wildlife and waterfowl from PWC-generated noise, physical disturbance and emissions.

On a cumulative basis, all visitor activities would continue to have negligible to minor adverse effects on wildlife and wildlife habitat.

This alternative would not result in an impairment of wildlife or wildlife habitat.

Impacts of Alternative B — Continue PWC Use under a Special NPS Regulation with Management Restrictions

Analysis. The number of PWC users would be the same as for alternative A, the only difference in area of use being the increased no-wake zone around the Buckhorn developed area. The type and magnitude of impacts to fish and other wildlife under alternative B would be similar to those under alternative A. Alternative B would result in negligible to minor impacts to wildlife similar to alternative A. Over the

next 10 years impacts would continue to be negligible since PWC numbers would not increase substantially. All wildlife impacts would be temporary and short term.

Cumulative Impacts. The cumulative impacts of alternative B would be essentially the same as those of alternative A, i.e., negligible to minor adverse impacts. Current and future impacts by PWC users and other visitors would not differ between alternatives.

Conclusion. Alternative B would have similar impacts to alternative A with respect to effects on wildlife. PWC use would have negligible to minor, temporary, adverse effects on wildlife and wildlife habitat.

Cumulative impacts on wildlife from all visitor activities would be negligible to minor.

This alternative would not result in an impairment of wildlife or wildlife habitat.

Impacts of Alternative C — Continue PWC Use under a Special Regulation but Limit Area of Use and Implement Other Restrictions

Analysis. The type of impact for fish and wildlife under alternative C would be similar to those described for alternative B, except that additional use and location restrictions, extending no-wake zones and potentially limiting the hours of operation and number of personal watercraft would reduce the magnitude of adverse impacts. There also would be general improvements to water quality and noise levels with the early enforcement of the EPA emission standards. The requirement for newer engines could reduce noise impacts, since some models are reported to be quieter than their two-stroke counterparts (Sea-Doo 2001b; Yamaha Motor 2001). There would also be less unburned oil/gas mixture released and a substantial reduction in hydrocarbons in exhaust, which would reduce the amount of oil-based pollutants available to adhere to sediments and potentially cause adverse effects through bioaccumulation. Direct impacts would be eliminated in the areas where PWC use would be prohibited — the Guy Sandy arm, the Rock Creek arm (starting just north of The Point campground), and within 150 feet of all shorelines. Since most wildlife are likely to be found near the shoreline, the 150-foot buffer along the shoreline, as well as extended no-wake zones, would reduce disturbance of wildlife. If numbers of personal watercraft were reduced on busy days as a result of establishing a carrying capacity through daily use permits, the potential for and intensity of wildlife disturbance would be similarly reduced. Timing restrictions (9 A.M. to 5 P.M.) would have beneficial impacts since most wildlife are more active during the early morning hours and at dusk. Under alternative C impacts on wildlife and wildlife habitat would be negligible at most locations. The requirement to use cleaner, quieter engines would contribute to an overall improvement to water quality and noise reductions beginning in 2005, which would be beneficial to wildlife.

Cumulative Impacts. Cumulative impacts to wildlife would be the similar, though slightly less, than those described for alternative B. While interactions between PWC users and wildlife would be eliminated or reduced, other visitors would still have access to the shoreline and could cause temporary flight responses in wildlife. As discussed in the "Water Quality" section, overall pollutant concentrations would be lower for personal watercraft by 2010 due to an expected 75% reduction in emission rates. However, the emission rate from other outboard motors would remain the same as in alternatives A and B. Cumulative impacts would be negligible to minor, temporary, and adverse.

Conclusion. Compared to alternative A, alternative C would have some beneficial effect on wildlife and waterfowl as a result of restricting PWC use at certain times and in certain locations, as well as requiring personal watercraft to meet the EPA emission standards by 2005. Direct impacts would be eliminated in all areas closed to PWC use, including a 150-foot buffer all along the lake shoreline (except for launching areas). Restricting use during early morning and dusk, when wildlife are most abundant and vulnerable,

would be beneficial. Similar to the other alternatives, PWC use would have negligible to minor, temporary, adverse impacts on wildlife; however, additional use restrictions would result in beneficial impacts.

Cumulative impacts from all visitor activities would continue to be negligible to minor and adverse.

No impairment would occur to fish or wildlife resources.

Impacts of the No-Action Alternative — No PWC Use

Analysis. PWC use would be discontinued on Lake of the Arbuckles. Compared to the other alternatives, this alternative could result in a beneficial effect to wildlife and wildlife habitat since interactions between PWC users and wildlife would be eliminated. The minor reduction in noise, particularly in areas previously subject to frequent PWC use, could result in some animals reinhabiting or using these areas.

Cumulative Impacts. Cumulative impacts to wildlife would be the similar to those described for alternative A. While interactions between PWC users and wildlife would be eliminated, other visitors would still have access to the shoreline and could cause temporary flight responses in wildlife. Cumulative impacts would be negligible to minor, temporary, and adverse.

Conclusion. Not allowing PWC use on Lake of the Arbuckles would result in a beneficial impact on wildlife and wildlife habitat because interactions between PWC users and wildlife would be eliminated. The minor reduction in noise could result in some animals potentially reinhabiting or using areas that would be closed to PWC use.

On a cumulative basis there would be negligible to minor adverse impacts on wildlife and wildlife habitat from other shoreline visitor activities. PWC contribution to overall impacts to wildlife and wildlife habitat would be eliminated.

No impairment of wildlife or wildlife habitat would result from this alternative.

THREATENED, ENDANGERED, OR SPECIAL CONCERN SPECIES

PWC use could potentially affect special status species similar to other wildlife by inducing flight and alarm responses, disrupting normal behaviors and causing stress, degrading habitat quality, and potentially affecting reproductive success.

GUIDING REGULATIONS AND POLICIES

The Endangered Species Act (16 USC 1531 et seq.) mandates that all federal agencies consider the potential effects of their actions on species listed as threatened or endangered. If the National Park Service determines that an action may adversely affect a federally listed species, consultation with the U.S. Fish and Wildlife Service is required to ensure that the action will not jeopardize the species' continued existence or result in the destruction or adverse modification of critical habitat.

State and federally listed species were identified through discussions with park staff, informal consultation with the U.S. Fish and Wildlife, and with the Oklahoma National Heritage Inventory. A letter requesting a current list of federal threatened, endangered, and special concern species was sent to

the U.S. Fish and Wildlife Service. The Oklahoma National Heritage Inventory and the Oklahoma Department of Wildlife Conservation were also contacted to identify state threatened, endangered, and special concern species (see appendix C).

An analysis of the potential impacts to each species listed in the USFWS letter is included in this section. At Chickasaw it has been determined that none of the alternatives would adversely affect any of the listed species. The completed environmental assessment will be submitted to the U.S. Fish and Wildlife Service for its review. If the agency concurs with the finding of the National Park Service, no further consultation will be required.

Formal consultation would be initiated if the National Park Service determined that actions in the preferred alternative would be likely to adversely affect one or more of the federally listed threatened or endangered species identified in the recreation area. At that point a biological assessment would be prepared to document the potential effects. From the date that formal consultation was initiated, the U.S. Fish and Wildlife Service would be allowed 90 days to consult with the agency and 45 days to prepare a biological opinion based on the biological assessment and other scientific sources. The Fish and Wildlife Service would state its opinion as to whether the proposed PWC activities would be likely to jeopardize the continued existence of the listed species or to result in the destruction or adverse modification of critical habitat. Such an opinion would be the same as a determination of impairment. To ensure that a species would not be jeopardized by PWC activities, the National Park Service would confer with the Fish and Wildlife Service to identify recommendations for reducing adverse effects and would integrate those into the preferred alternative.

NPS *Management Policies 2001* state that potential effects of agency actions will also be considered on state or locally listed species. The National Park Service is required to control access to critical habitat of such species, and to perpetuate the natural distribution and abundance of these species and the ecosystems upon which they depend.

The animal species at Chickasaw that have the potential to be affected by proposed PWC management alternatives include the federally listed bald eagle (threatened), whooping crane (endangered) and interior least tern (endangered). The two rare species, not legally protected under the Endangered Species Act, include the alligator snapping turtle and the Oklahoma cave amphipod. No federal or state listed plant species are known to occur in Chickasaw.

ASSUMPTIONS AND METHODOLOGIES

Primary steps in assessing impacts on listed species were taken to determine the following:

1. which species are found in areas likely to be affected by management actions described in the alternatives
2. current and future use and distribution of personal watercraft by alternative
3. habitat loss or alteration caused by the alternatives
4. displacement and disturbance potential of the actions and the species' potential to be affected by PWC activities

The information in this analysis was obtained through best professional judgment of park staff and experts in the field (as cited in the text), and by conducting a literature review.

As related to threatened or endangered species, the following rules apply:

- Personal watercraft must operate no closer than 150 feet from shore unless landing or launching.
- When personal watercraft land or launch, they must operate at no-wake speed if within 150 feet of the shore.

Two basic assumptions were made regarding personal watercraft and visitor activities, as follows:

- Most visitors use existing trails and do not walk off trail.
- PWC and boat users who access the shore would likely not travel farther than 100 feet from their craft and would stay within eye contact when on shore.

The PWC and visitor use trends data were used to evaluate impacts to threatened or endangered species. Additional information was obtained from park staff. Vegetation and wildlife information was provided by the Chickasaw staff biologist, NPS reports, and contacts with the U.S. Fish and Wildlife Service, the Oklahoma Department of Wildlife Conservation, and the Oklahoma Natural Heritage Inventory.

IMPACT ANALYSIS AREA

The impact analysis area is Lake of the Arbuckles and adjacent areas extending inland approximately 200 feet, which would provide a more encompassing range of assessment, based on wildlife responses to PWC activity and the likely distance PWC users would travel inland.

IMPACT OF PWC USE ON SUCH SPECIES

The Endangered Species Act defines the terminology used to assess impacts to listed species as follows:

> *No effect:* When a proposed action would not affect a listed species or designated critical habitat.
>
> *May affect / not likely to adversely affect:* Effects on special status species would be discountable (i.e., extremely unlikely to occur and not able to be meaningfully measured, detected, or evaluated) or would be completely beneficial.
>
> *May affect / likely to adversely affect:* When an adverse effect to a listed species might occur as a direct or indirect result of proposed actions and the effect would either not be discountable or would be completely beneficial.
>
> *Is likely to jeopardize proposed species / adversely modify proposed critical habitat (impairment):* The appropriate conclusion when the National Park Service or the U.S. Fish and Wildlife Service identifies situations in which PWC use could jeopardize the continued existence of a proposed species or adversely modify critical habitat to a species within or outside park boundaries.

Impacts of Alternative A — Continue PWC Use under a Special NPS Regulation

Analysis. This alternative would allow continued PWC use on Lake of the Arbuckles, with an average of 66 PWC users on a peak summer day in 2002, increasing to 73 PWC users per day by 2012.

> *Bald Eagle, Interior Least Tern, and Whooping Crane* — These protected species are primarily winter residents at Chickasaw, although whooping cranes were sighted over Lake of the Arbuckles in October 2002 (NPS 2002c). There is no documented evidence of breeding or

nesting by these species in Chickasaw. There has been no noticeable adverse impact of PWC use on the birds based on the NPS staff biologist's experience in the national recreation area. Off-season PWC would have negligible or minor effects on the birds occasionally feeding in the area.

Alligator snapping turtle and Oklahoma cave amphipod — The alligator snapping turtle could be exposed to PWC use along the shoreline during the nesting season; however, the turtles are likely to occur within the no-wake zones, which would minimize adverse effects. There would be no direct impact to the amphipod, which may occur in caves along the shoreline. Potential water quality effects are not known.

Plant Species of Special Concern — There are no federal or state listed plant species at Chickasaw. However, nine species of special concern are listed by the Oklahoma Natural Heritage Inventory. If these plants were present along the shoreline, individual plants could be adversely affected by trampling. However, the populations within the park are not likely to be jeopardized.

Actions under alternative A may affect, but are not likely to adversely affect, any of the listed wildlife or plant species. While some birds could exhibit a stress or flight response due to PWC activities, these impacts would be only temporary. Long-term water quality effects on the amphipod are not known.

Cumulative Impacts. Cumulative effects from all park visitor activities are not likely to adversely affect wildlife species because the protected species are only transient winter residents and are not commonly present in the areas frequented by off-season visitors. If the plant species of special concern were present in areas frequented by visitors, there could be adverse effects from trampling, but populations within the park are not likely to be jeopardized.

Conclusion. PWC use may affect, but is not likely to adversely affect, any listed wildlife or plant species that may occur at Chickasaw. PWC use would not likely adversely affect any of the special status species since interactions would be extremely limited. While some birds could exhibit a stress or flight response because of PWC activities, impacts would be temporary. Long term water quality effects on the amphipod are not known.

Cumulative effects from all park visitor activities are not likely to adversely affect listed wildlife species because they are transient winter residents, and impacts on individual plants would not jeopardize species populations within the park.

This alternative would not result in an impairment to any listed species at Chickasaw.

Impacts of Alternative B — Continue PWC Use under a Special NPS Regulation with Management Restrictions

Analysis. Impacts would be the same as described for alternative A. The increased no-wake zone around the Buckhorn developed area would have a negligible impact on any of the listed wildlife or plant species. Impacts to plant species of special concern would be the same as described for alternative A. Also, under alternative B habitat areas could be closed as needed to protect threatened or endangered species. In the areas of restricted PWC use, any potential conflicts would be eliminated.

Interactions between protected birds and PWC users would have the same impacts as for alternative A and would not likely adversely affect the species, since the interactions would be very limited during the time of year when the birds are present.

Cumulative Impacts. As described for alternative A, cumulative effects from all park visitor activities are not likely to adversely affect wildlife species because the protected species are only transient winter residents and are not commonly present in the areas frequented by off-season visitors. If the plant species of special concern were present in areas frequented by visitors, there could be adverse effects from trampling, but populations within the park are not likely to be jeopardized.

Conclusion. PWC use under alternative B may affect, but is not likely to adversely affect, any listed wildlife or plant species at Chickasaw. While some disturbance could occur to transient wildlife species from off-season PWC use, the impacts would not be of sufficient duration or intensity to cause adverse impacts. No impacts would occur in areas where PWC use would be prohibited.

As described for alternative A, cumulative impacts from all park visitor activities are not likely to adversely affect listed species. Listed wildlife species are only transient winter residents, and any impacts on individual plants would not jeopardize species populations within the park.

No impairment to any listed species would occur under this alternative.

Impacts of Alternative C — Continue PWC Use but Limit Area of Use and Implement Other Restrictions

Analysis. Impacts would be similar to those described for alternative B, except that additional use and location restrictions, extending no-wake zones, and limiting hours of operation or possibly numbers of personal watercraft would slightly reduce the potential for adverse impacts if the special status species or plants of special concern were present. Noise generated from newer engines that would be required beginning in 2005 would lessen chances of disturbance to listed bird species. These migratory birds are primarily present only in the winter months, and it is unlikely that more than negligible to minor impacts would occur. Also, habitat areas could be closed as needed to protect threatened or endangered species. In the areas of restricted PWC use, any potential conflicts would be eliminated.

Cumulative Impacts. As described for alternative A, cumulative effects from all park visitor activities are not likely to adversely affect wildlife species because the protected species are only transient winter residents and are not commonly present in the areas frequented by off-season visitors. Cumulative impacts to individual plants from trampling would not jeopardize populations within the park, similar to alternative A.

Conclusion. PWC use under alternative C may affect, but is not likely to adversely affect, any listed species in Chickasaw. While some disturbance could occur from off-season PWC use, impacts would be not be of sufficient duration or intensity to cause adverse impacts. No impacts would occur in designated areas where PWC use would be prohibited.

As described for alternative A, cumulative impacts from all park visitor activities are not likely to adversely affect listed species. Listed wildlife species are only transient winter residents, and any impacts on individual plants would not jeopardize species populations within the park.

No impairment to any listed wildlife or plant species would occur under this alternative.

Impacts of the No-Action Alternative — No PWC Use

Analysis. No PWC use would be allowed in Lake of the Arbuckles, thus eliminating any potential impacts on the special status species, a beneficial effect.

Cumulative Impacts. The activities of other visitors are not likely to adversely affect federal or state listed species.

Conclusion. There would be no effect on the special status species because of a ban on PWC use.

On a cumulative basis impacts from other visitor activities and boating are not likely to adversely affect the listed species, similar to the other alternatives. PWC contribution to overall cumulative impacts to protected species would be eliminated.

This alternative would not result in an impairment of threatened or endangered species.

SHORELINES AND SHORELINE VEGETATION

Personal watercraft provide access to the shoreline, and operators may disembark to explore or sunbathe. As a result, shoreline vegetation could be trampled in order to access shoreline trails or to explore along the shore. PWC users are able to access areas where most other motorcraft cannot go, which may disturb sensitive plant species. In addition, wakes created by personal watercraft may affect shorelines and cause erosion.

GUIDING REGULATIONS AND POLICIES

Natural shoreline processes such as erosion, deposition, overwash, inlet formation, and shoreline migration should continue without interference. Where the nature or rate of natural shoreline processes has been altered, the National Park Service is directed to identify alternatives for mitigating the effects of such activities or structures and for restoring natural conditions (NPS *Management Policies 2001,* sec. 4.8.1.1). The National Park Service must also comply with the provisions of Executive Order 11990 ("Protection of Wetlands"), which requires federal agencies to avoid short- and long-term adverse impacts associated with the destruction or modification of wetlands whenever possible

METHODOLOGY AND ASSUMPTIONS

Potential impacts to shoreline vegetation and to the shoreline itself (erosion that can affect shoreline communities) were evaluated based on the pattern of use of motorized watercraft on Lake of the Arbuckles, the nature of the shoreline and vegetation present, and the professional judgment and observations of park staff. To assess the magnitude of impacts from PWC use on shoreline vegetation, the following assumptions were made:

1. Most PWC users operate their craft in a lawful manner and abide by state laws and park regulations
2. PWC users who disembark on the shore would travel no more than 100 feet inland and would follow existing trails.
3. PWC use is projected to increase only 1% per year now through 2012.

IMPACT ANALYSIS AREA

The impact analysis area for the assessment includes the immediate water/land interface along the shoreline of Lake of the Arbuckles where PWC use is allowed.

IMPACT TO SENSITIVE SHORELINE VEGETATION FROM PWC USE AND VISITOR TRAMPLING

Shoreline vegetation impacts were determined by examining the potential effects of PWC and visitor use on vegetation, according to type and sensitivity. The number of personal watercraft and visitors and their distribution was based on the analysis provided in the "PWC Use Trends" section. The following impact thresholds were established to describe the relative changes in shoreline vegetation under the various alternatives being considered:

Negligible: Impacts would have no measurable or perceptible changes in plant community size, integrity, or continuity.

Minor: Impacts would be measurable or perceptible but would be localized within a relatively small area. The overall viability of the plant community would not be affected and, if left alone, would recover.

Moderate: Impacts would cause a change in the plant community (e.g. abundance, distribution, quantity, or quality); however, the impact would remain localized.

Major: Impacts to the plant community would be substantial, highly noticeable, and permanent.

Impairment: PWC use would contribute substantially to the deterioration of the shoreline or shallow water environment to the extent that the park's shoreline or submerged vegetation would no longer function as a natural system. In addition, these adverse major impacts to park resources and values would

contribute to deterioration of these resources to the extent that the park's purpose could not be fulfilled as established in its enabling legislation;

affect resources key to the park's natural or cultural integrity or opportunities for enjoyment; or

affect the resource whose conservation is identified as a goal in the park's general management plan or other park planning documents.

Impacts of Alternative A — Continue PWC Use under a Special NPS Regulation

Analysis. The central part of Lake of the Arbuckles would continue as a high-use area for personal watercraft. The majority of shoreline use is near the boat launch points of The Point, Buckhorn, and Guy Sandy. Other high-use areas include in front of The Point and adjacent to the Buckhorn developed area. During July 2002, approximately 1,002 personal watercraft were observed on the lake, and as previously discussed PWC use is projected to increase 1% per year through the year 2012 (see page 70).

No-wake zones have been delineated in the Upper Guy Sandy, Rock Creek, Buckhorn and Dry Branch lake arms; and no-wake restrictions are in effect within 150 feet of all docks, launch ramps, and shoreline areas near campgrounds. Three areas are closed to all vessels to protect swimmers — the Goddard Youth Camp Cove, an area surrounding The Point, and certain areas near Buckhorn. However, violations of the no-wake zone do occur in all closed areas, including the Rock Creek area.

While PWC use would be distributed throughout the lake, the primary location for potential impacts to the shoreline and shoreline vegetation would be near camping areas and boat launch areas, private properties where landowners moor their craft, and in shallow areas and small arms within larger arms such as Rock Creek (S. Burrough, NPS, pers. comm., R. Wieland, URS, Oct. 2, 2002). Currently, impacts include wave erosion related to PWC use, sedimentation of nearshore emergent wetlands, and trampling by PWC operators landing their craft and walking on shore. However, these impacts are minor; no changes in plant communities have been observed due to PWC or other motorcraft action. Impacts would increase slightly each year due to a small projected increase in PWC use, but would likely remain negligible to minor.

Continued PWC use at Chickasaw would have negligible to minor adverse impacts to sensitive shoreline vegetation over the short and long term, with either no perceptible changes in plant community size, integrity, or continuity; or minor localized impacts.

Cumulative Impacts. The largest group of motorized watercraft in the national recreation area is motorboats, and visitors use trails and other types of watercraft to access shoreline areas. Generally, most visitors follow trails and do not trample shoreline vegetation. Erosion is primarily caused by high winds and wave action, and by human uses such as parking boats along shorelines, hiking, and camping (S. Burrough, NPS, pers. comm., R. Wieland, URS, Oct. 2, 2002). Overall, physical processes, plus PWC and other visitor use at Chickasaw, have resulted in a negligible to minor, short- and long-term, adverse effects on shoreline vegetation, with either no perceptible changes in plant community size, integrity, or continuity.

Conclusion. PWC use at Chickasaw would result in negligible to minor, localized adverse impacts on shoreline vegetation over the short and long term, with no perceptible changes in plant community size, integrity, or continuity.

Cumulative impacts include other sources of shoreline erosion that create impacts greater that those caused by PWC use, including high boat use. Overall, personal watercraft and other sources of cumulative impacts would create negligible to minor, short and long term, adverse impacts on the shoreline or shoreline vegetation.

This alternative would not result in an impairment of shoreline vegetation.

Impacts of Alternative B — Continue PWC Use under a Special NPS Regulation with Additional Management Restrictions

Analysis. Monitoring would be conducted at selected locations to establish baseline conditions and to measure impacts on shoreline erosion as a result of PWC use. Monitoring the shoreline would identify areas in need of greater protection. The increased no-wake zone around the Buckhorn developed area would eliminate impacts to shoreline vegetation in that area. In all other areas of the lake, PWC use and impacts under alternative B would be the same as those described for alternative A. Overall, PWC use would result in a negligible to minor, localized, adverse impact on shoreline vegetation over the short and long term, with no perceptible changes in plant community size, integrity, or continuity.

Cumulative Impacts. Cumulative impacts related to other visitor activities would be the same as described for alternative A and would be negligible to minor, short and long term, and adverse. There would be no perceptible changes to plant community size, integrity or continuity, now or in the future (2012).

Conclusion. PWC use would have negligible to minor, localized, adverse impacts to sensitive shoreline vegetation over the short and long term, with no perceptible changes in plant community size, integrity, or continuity. Monitoring under this alternative would provide beneficial feedback on the condition of certain areas.

Cumulative impacts related to other visitor activities would be the same as described for alternative A and would be negligible to minor, short and long term, and adverse. There would be no perceptible changes to plant community size, integrity or continuity, now or in the future (2012).

This alternative would not result in an impairment of shoreline vegetation.

Impacts of Alternative C — Continue PWC Use under a Special NPS Regulation but Limit Area of Use and Implement Other Restrictions

Analysis. PWC use would continue to be allowed, but the area of use would be limited and additional use restrictions would be enforced. This alternative would eliminate potential impacts to shoreline vegetation in the current no-wake zones of the Guy Sandy arm and the Rock Creek arm and other proposed exclusion zones, as well as extended no-wake zones. Any impacts to shoreline vegetation caused by PWC use would be eliminated because no use would be allowed within 150 feet of the shore in the remaining areas. A large percentage of the shoreline of Lake of the Arbuckles would either no longer be accessible to PWC users, or only when they were traveling at no-wake speeds.

Under this alternative, the National Park Service would also either confine PWC use to the times between 9 A.M. and 5 P.M., or limit PWC use to weekends and holidays only. However, PWC use is currently restricted between sunset and sunrise, and the heaviest use occurs on weekends and holidays. In addition, the National Park Service would establish a carrying capacity and limit PWC permits to day-use only and set a maximum number of permits per day under this alternative. The number of permits that would be issued is not known, but it is assumed that the number would not increase from current use levels.

Restricting PWC use would result in beneficial impacts to sensitive shoreline vegetation over the short and long term, since PWC-related the wave action would be reduced. Impacts related to PWC users landing on the shoreline would also be reduced.

Cumulative Impacts. Cumulative impacts related to other visitor activities would be the same as those described for alternative A. Use of other motorized vessels, which outnumber personal watercraft, would continue to result in negligible to minor, short- and long-term, adverse impacts. There would be a negligible reduction of overall impacts by restricting PWC use.

Conclusion. Restricting PWC use would result in beneficial impacts to sensitive shoreline vegetation over the short and long term, with no perceptible changes in plant community size, integrity, or continuity.

Cumulative impacts related to other visitor activities would be negligible to minor, short and long term, and adverse, the same as for alternative A. There would be a negligible reduction of overall impacts by restricting PWC use.

This alternative would not result in an impairment of shoreline vegetation.

Impacts of the No-Action Alternative — No PWC Use

Analysis. Banning PWC use within the national recreation area would eliminate any potential impacts to shoreline vegetation as a result of access gained from personal watercraft, or impacts due to wave action from PWC use. Eliminating PWC use would result in beneficial impacts to sensitive shoreline vegetation over the short and long term, with no perceptible changes in plant community size, integrity, or continuity now or by 2012.

Cumulative Impacts. Cumulative impacts would be similar to those described for alternative A except that any contribution to these impacts from PWC use would be eliminated. Ongoing use of the shoreline by other visitors would continue to have negligible to minor adverse impacts over the short and long term.

Conclusion. Banning PWC use would result in beneficial impacts to sensitive shoreline vegetation over the short and long term, with no perceptible changes in plant community size, integrity, or continuity.

Cumulative impacts related to other visitor activities would be negligible to minor, short and long term, and adverse, the same as for alternative A. There would be a negligible reduction of overall impacts by banning PWC use.

This alternative would not result in an impairment of shoreline vegetation.

VISITOR EXPERIENCE

Some research suggests that PWC use is viewed by some segments of the public as a nuisance due to their noise, speed, and overall environmental effects, while others believe that personal watercraft are no different from other motorcraft and that people have a right to enjoy the sport. The primary concern involves changes in noise, pitch, and volume due to the way personal watercraft are operated. Additionally, the sound of any watercraft can carry for long distances, especially on a calm day.

GUIDING REGULATIONS AND POLICIES

NPS *Management Policies 2001* state that the enjoyment of park resources and values by the people of the United States is part of the fundamental purpose of all parks and that the National Park Service is committed to providing appropriate, high-quality opportunities for visitors to enjoy the parks. Because many forms of recreation can take place outside a national park setting, the National Park Service will therefore seek to

- provide opportunities for forms of enjoyment that are uniquely suited and appropriate to the superlative natural and cultural resources found in a particular unit
- defer to local, state, and other federal agencies; private industry; and non-governmental organizations to meet the broader spectrum of recreational needs and demands that are not dependent on a national park setting

Unless mandated by statute, the National Park Service will not allow visitors to conduct activities that

- would impair park resources or values,
- would create an unsafe or unhealthful environment for other visitors or employees,
- are contrary to the purposes for which the park was established, or

- would unreasonably interfere with the atmosphere of peace and tranquility, or the natural soundscape maintained in wilderness and natural, historic, or commemorative locations within the park; NPS interpretive, visitor service, administrative, or other activities; NPS concessioner or contractor operations or services; or other existing, appropriate park uses.

Based on the legislative intent, part of the purpose of Chickasaw is to provide outdoor recreation. The laws creating Chickasaw direct the National Park Service to provide public outdoor recreation use and enjoyment of Lake of the Arbuckles.

To achieve this mission goal, two long-term (five-year) visitor goals were identified in the park's *Strategic Plan:*

- *Visitor Satisfaction* — By September 30, 2005, 95% of visitors to Chickasaw are satisfied with appropriate facilities, services, and recreational opportunities.
- *Visitor Safety* — By September 30, 2005, the number of Chickasaw visitor accidents/incidents is reduced from the FY 1992 – FY 1996 five-year annual average of 8 to 6 (25% decrease).

In addition, park staff have defined an additional goal related to visitor experience at Chickasaw:

> Provide an appropriately wide range of recreational activities consistent with protecting the values of conservation.

These goals focus on maintaining high visitor satisfaction by means of appropriate and safe recreational opportunities and experiences.

The national recreation area's enabling legislation identifies public outdoor recreation, and hunting and fishing, as important elements of the visitor experience. In addition to providing outdoor recreation, the park's purpose includes administering scenic, scientific, natural, and historical values.

METHODOLOGIES AND ASSUMPTIONS

The purpose of this impact analysis was to determine if PWC use at Chickasaw is compatible or in conflict with the purpose of the park, its visitor experience goals, and the direction provided by NPS *Management Policies*. Thus, these policies and goals were integrated into the impact thresholds.

To determine impacts, the current level of PWC use was calculated for areas of the national recreation area. Other recreational activities and visitor experiences that are proposed in these locations were also identified. Visitor surveys and staff observations were evaluated to determine visitor attitudes and satisfaction in areas where personal watercraft are used. Baseline visitor survey data at Chickasaw suggest that the vast majority of visitors are satisfied with their current experiences.

The potential for change in visitor experience was evaluated by identifying projected increases or decreases in both personal watercraft and other visitor uses, and determining whether these projected changes would affect the desired visitor experience and result in greater safety concerns or additional user conflicts.

IMPACT ANALYSIS AREA

In terms of PWC use, the appropriate boundary for analyzing visitor experience impacts includes Lake of the Arbuckles and areas within 200 feet of the shore where PWC use may affect visitors at beaches, trails, and campgrounds.

IMPACT OF PERSONAL WATERCRAFT ON VISITOR EXPERIENCE GOALS

The following thresholds for evaluating impacts on visitor experience were defined:

> *Negligible:* Visitors would not likely be aware of the effects associated with changes proposed for visitor use and enjoyment of park resources.
>
> *Minor:* Visitors would likely be aware of the effects associated with changes proposed for visitor use and enjoyment of park resources; however the changes in visitor use and experience would be slight and likely short term. Other areas in the park would remain available for similar visitor experience and use without derogation of park resources and values.
>
> *Moderate:* Visitors would be aware of the effects associated with changes proposed for visitor use and enjoyment of park resources. Changes in visitor use and experience would be readily apparent and likely long term. Other areas in the park would remain available for similar visitor experience and use without derogation of park resources and values, but visitor satisfaction might be measurably affected (visitors could be either satisfied or dissatisfied). Some visitors who desire to continue their use and enjoyment of the activity/visitor experience would be required to pursue their choice in other available local or regional areas.
>
> *Major:* Visitors would be highly aware of the effects associated with changes proposed for visitor use and enjoyment of park resources. Changes in visitor use and experience would be readily apparent and long term. The change in visitor use and experience proposed in the alternative would preclude future generations of some visitors from enjoying park resources and values. Some visitors who desire to continue their use and enjoyment of the activity / visitor experience would be required to pursue their choices in other available local or regional areas.

Impacts of Alternative A — Continue PWC Use under a Special Regulation

Analysis. PWC operators under alternative A would have unrestricted use along the Lake of the Arbuckles shoreline, increasing from 66 personal watercraft on a high-use summer day to 73 by 2012. The majority of shoreline visitors currently use areas near the boat launch ramps at The Point, Buckhorn, and Guy Sandy, which is also where 98% of all watercraft operators launch. In addition, high-use areas for personal watercraft include waters adjacent to The Point and the Buckhorn developed area.

Impacts on PWC Users — There would be no change to PWC use or activity, and there would be no effect on the experiences of PWC users at Chickasaw.

Impacts on Other Boaters — Other boaters at Chickasaw constitute 70% to 80% of the use on the lake, and they would continue to interact with PWC operators. However, the park estimates that the number of personal watercraft is increasing each year, while the number of other boats is decreasing.

The central part of the main body of Lake of the Arbuckles is a high-use area for personal watercraft and may also be frequented by sailboats, which can require large areas of open water. However, the park has prohibited motorboats and personal watercraft from waterbodies 100 acres or less, so nonmotorized

watercraft users can recreate on Veterans Lake and other smaller lakes. In addition, the park has established no-wake areas for sailboating and canoeing, such as the Rock Creek and Upper Guy Sandy arms of the lake, which lead to creeks that are favored by canoeists and kayakers. Therefore, impacts to nonmotorized boaters would be negligible to minor adverse.

Motorboats are more likely to interact with personal watercraft. The most common area for personal watercraft / boater interaction is near the boat launches — about 98% of motorcraft operators launch at Buckhorn, The Point, and Guy Sandy. Based on this analysis, alternative A would have negligible to minor, short- and long-term, adverse impacts on the experiences of other motorized boat users

Impacts on Other Visitors — Campers, swimmers, anglers, hikers, and other shoreline visitors to Lake of the Arbuckles area would continue to have contact with PWC users. In addition to the main body of the lake, other high-use areas for personal watercraft include picnic areas and campgrounds in the vicinity of the Buckhorn developed area, which is also popular with swimmers. There are four campground loops (with a total of 142 campsites and a limit of 10 campers per non-group site) in the Buckhorn area. Campground quiet hours are from 10 P.M. until 6 A.M., and PWC use is prohibited between sunset and sunrise. The park has closed two areas near the Buckhorn picnic area and the campground to boat use, which should help reduce impacts to picnickers, campers, and visitors who swim in this area. In addition, the "Superintendent's Compendium" restricts watercraft to no-wake speed (5 mph) adjacent to campgrounds.

Visitors can swim in the smaller lakes and creeks that the park has closed to PWC use. In addition, the park has closed three areas of Lake of the Arbuckles to all vessels to protect swimmers — the Goddard Youth Camp Cove, an area surrounding The Point, and certain areas near Buckhorn. However, these closures are violated at Buckhorn and The Point when watercraft access the picnic areas at these sites, which could affect swimmers. Park staff have received complaints from swimmers about PWC operators not slowing down in swim areas.

Three hiking trails exist in the Arbuckle District: two at The Point (Fishing Rock Trail and Lakeview Trail) and one in the Buckhorn area. The Fishing Rock trail follows the Lake of the Arbuckles shoreline for almost a mile, and hikers and anglers can access the shore in several places. The Buckhorn area trail also follows the lake shoreline. An increase in PWC use in these popular areas could affect hikers and shoreline anglers seeking natural quiet. Anglers who seek solitude can also fish in Veterans Lake, which is closed to motorized watercraft, and several additional trails throughout the park are available for hiking.

Continued PWC use would not result in a noticeable change in visitor experiences because the park already provides protection for canoeists, sailboaters, campers, and swimmers. Also, other areas where personal watercraft are not allowed are available for park activities. However, continued violations of no-wake zones and an expected increase in PWC use at congested areas in Lake of the Arbuckles could affect shoreline visitors (particularly swimmers) in the long term. Based on this analysis and the 2001 survey that shows a 96% overall visitor satisfaction rating with park experiences, PWC activity in Lake of the Arbuckles would have negligible to minor adverse impacts on the experiences of these shoreline visitors.

In summary, continued unrestricted PWC use in the national recreation area would have no effect on PWC users. Swimmers and other motorized boat users would be most affected by continued PWC use because of the popularity of the boat ramps and swim areas at Buckhorn, The Point, and Guy Sandy. PWC use would have negligible to minor adverse impacts for visitors who desire a more passive recreational experience. Overall, most visitors to Chickasaw would experience negligible to minor

adverse effects under this alternative and would continue to be satisfied with their experiences at Chickasaw.

Cumulative Impacts. The primary activities at Chickasaw that may affect visitor experiences include the number and activities of other visitors and noise from vehicles and motorboats. The only roads near the lake are used to access recreational sites, and one road within the park parallels the lake to the south. Land-based motor vehicle noise would be minimal. A proposed plan to sell water in the Arbuckle Simpson Aquifer could affect the quantity and quality of water in Lake of the Arbuckles. For example, if lake levels receded, boat ramps and swim beaches could become unusable. However, it is too early to predict what, if any, effects the aquifer water sale would have. According to visitor surveys, most visitors are satisfied with their experiences at the recreation area. Cumulative impacts related to the use of personal watercraft, motorized boats, and other visitor activities would be negligible to minor over the short and long term.

Conclusion. Continued PWC use would have negligible to minor adverse impacts on the experiences of most visitors in the short and long term. PWC use would have negligible to minor adverse impacts on other boaters due to increased congestion at popular boat launches. PWC use would have long-term, negligible to minor, adverse impacts on swimmers and those visitors desiring natural quiet because the park currently protects the experiences of these users.

Cumulative effects of PWC use, other watercraft, and other visitors would result in negligible to minor, short- and long-term, adverse impacts.

Impacts of Alternative B — Continue PWC Use under a Special Regulation with Additional Management Prescriptions

Analysis. Under alternative B, PWC operators would be required to carry state boat registration cards or information about their machine's model year and emissions. Fueling would only be allowed while the unit was trailered and away from the water surface. A voluntary, self-regulatory PWC user group would develop rules and guidelines for PWC use, and a new program would monitor visitor use patterns. The requirement that any 12-year-old PWC operator must be accompanied by an adult would affect a small number of PWC operators. The increased no-wake zone around the Buckhorn developed area would affect PWC users traveling in and out of the area. User fees for all visitors would be increased to cover higher monitoring and enforcement costs of new restrictions, resource management programs, and the cost of a PWC educational program. User fee refunds or rate reductions would be offered for users voluntarily complying with the EPA 2006 marine engine emission standards. Some sites could be seasonally or permanently closed as needed to protect cultural resources and threatened or endangered species.

Impacts on PWC Users — Carrying a registration card or model year and emissions information would not unduly burden PWC owners. Other than the increased no-wake zone around the Buckhorn developed area, no additional areas would be closed to PWC use except on an as-needed basis, such as seasonal or permanent closures to protect park resources. Fueling watercraft away from the water surface would possibly result in a minor inconvenience. Under this alternative visitors who use personal watercraft at Chickasaw would experience minor adverse impacts. An increased user fee could result in an adverse impact, but this would be offset for those users who voluntarily complied with the EPA emission standards. Management restrictions under this alternative would result in minor to moderate adverse impacts to visitors who use personal watercraft at Chickasaw.

Impacts on Other Boaters — Impacts to other boaters would be very similar to those described under alternative A, because restrictions under alternative B would be specific only to PWC operators and would not affect areas or hours of operation or the number of users permitted on the lake. There could be fewer PWC users on the lake, and this would reduce conflicts with boaters. Impacts to other boaters would continue to be negligible to minor, long term, and adverse.

Impacts on Other Visitors — Impacts to other shoreline users would be similar to those discussed under alternative A. Other visitors, particularly swimmers, may notice a slight beneficial impact due to PWC operators refueling their watercraft in parking areas away from the shoreline and the extended no-wake zone around the Buckhorn developed area. Impacts to other visitors would continue to have negligible to minor adverse impacts on the experiences of these shoreline visitors.

Cumulative Impacts. Cumulative impacts would be the same for all visitors, as described under alternative A, except for PWC users. Cumulative impacts related to the use of personal watercraft, motorized boats, and other visitor activities would be negligible to minor over the short and long term.

Conclusion. PWC users would experience minor to moderate adverse effects over the short and long term because of management restrictions. Impacts of PWC use on other boaters and visitors would be negligible to minor, short and long term, and adverse.

Cumulative effects of PWC use, other watercraft, and other visitors would result in negligible to minor, short- and long-term, adverse impacts to most visitors in the park.

Impacts of Alternative C — Continue PWC Use but Limit Area of Use and Implement Other Restrictions

Analysis. PWC use would be restricted to the main body and some arms of Lake of the Arbuckles; additional sites could be seasonally or permanently closed as needed to protect cultural resources and threatened or endangered species. PWC use would also be prohibited in the no-wake zones of the Guy Sandy arm and the Rock Creek arm (now PWC use would be allowed just north of The Point campground). Two Buckhorn arm no-wake zones would also be extended. A PWC carrying capacity would be set by limiting PWC permits to day-use only and setting a maximum number of permits per day. PWC operators would be required to stay 150 feet from the shoreline (except for launch ramps and mooring areas). The age requirement for PWC operators would be increased to 16. PWC use could either be restricted to the hours of 9 A.M. to 5 P.M., or limited to weekends and holidays. A PWC user educational program would be established and funded by increased user fees. User fee refunds or rate reductions would be offered for users voluntarily complying with the EPA 2006 emission standards prior to 2005.

Impacts on PWC Users — PWC users would experience the same impacts as under alternative B, with additional access restrictions. Personal watercraft would be prohibited in the northern Rock Creek and Upper Guy Sandy arms, which are currently defined as no-wake zones (the Rock Creek zone would be extended slightly); PWC use has already been reduced in these areas. No additional areas would be prohibited to PWC use except on an as-needed basis, such as seasonal or permanent closures to protect park resources. Extending the no-wake zone in the eastern arm of the lake would result in a negligible impact on PWC users. Limiting PWC use to 150 feet from the shoreline would tend to concentrate users in the main body of the lake, an area that is already favored by PWC users. Physical area closures and extended no-wake zones would have a negligible to minor impact on most PWC users, because the most popular PWC locations would remain available for use. The requirement to meet the EPA 2006 emission standards by 2005 would have a moderate to major adverse effect on PWC users.

Establishing a carrying capacity and limiting the number of permits available to PWC users could result in adverse impacts, depending on how restrictive the limits were. Some PWC users could arrive at the lake to find that the maximum number of permits had already been issued, preventing them from using their watercraft in the park on that day. Raising the age requirement from 12 to 16 years old could prevent a small number of riders from operating a personal watercraft. Decreasing the hours of operation would result in a minor adverse impact, since the majority of daylight hours would still be available for PWC operation. Alternatively, limiting PWC use to weekends and holidays would have a minor to moderate adverse impact, because local users who visit the park on weekdays after work would no longer be able to do so. An increased user fee could also result in an adverse impact, but this would be offset for those users who voluntarily comply with the EPA emission standards prior to 2005. Management restrictions under this alternative would result in minor to moderate adverse impacts to visitors who use personal watercraft at Chickasaw.

Impacts on Other Boaters — Other boaters to Chickasaw would continue to interact with PWC operators and experience impacts similar to alternative A. Non-motorized boat users would experience minor to moderate beneficial impacts due to PWC closures in the northern sections of the Upper Guy Sandy and Rock Creek arms of the lake. A 150-foot buffer zone along the shoreline would also benefit canoeists and kayakers who travel the lake along the shore. Expanded no-wake zones would also benefit non-motorboat users. As under alternative A, motorboaters would continue to be more likely to interact with PWC users, but only on weekends and holidays if a weekday restriction went into effect. Limiting PWC use with a permit system could also result in beneficial impacts to other boaters. The most common area for personal watercraft / boater interaction is near the boat launches — about 98% of motorcraft operators launch at Buckhorn, The Point, and Guy Sandy. Nonmotorized boaters and other motorized boaters would experience beneficial effects now and in the future as a result of restricted PWC use.

Impacts on Other Visitors — Shoreline anglers and campers who overnight in the Buckhorn area, where PWC use is popular, would experience longer periods of natural quiet if PWC operations were restricted to the hours between 9 A.M. and 5 P.M. Alternatively, restricting PWC use to holidays and weekends would benefit local anglers and park visitors who camp for extended periods of time. Swimmers and anglers would experience beneficial impacts due to PWC day-use permit limitations and extended no-wake zones along the shoreline in the Buckhorn area and the eastern arm of the lake. Permit limitations and the 150-foot buffer zone around the lake would also have beneficial impacts to these and other visitors, such as hikers, seeking natural quiet. In addition, other shoreline visitors would experience beneficial impacts as a result of limiting PWC use. Overall, alternative C would result in beneficial impacts to other visitors at the park.

Cumulative Impacts. As under alternative A, the primary activities at Chickasaw that may affect visitor experiences include the number and activities of other visitors and noise from vehicles and motorboats. Cumulative impacts related to the use of personal watercraft, motorized boats, and other visitor activities would be negligible to minor over the short and long term.

Conclusion. Extending area closures to PWC use would have negligible to minor, short- and long-term, adverse impacts on most PWC users, because the most popular use areas would remain open. However, PWC users would experience minor to moderate, short- and long-term, adverse impacts due to increased management restrictions, such as limiting the number of day-use permits and reducing daily use hours or days of operation. The requirement to meet the EPA emission standards by 2005 would have a moderate to major adverse effect on PWC users. Restrictions on PWC use would have beneficial impacts on other boaters and recreationists.

Cumulative impacts on visitor experiences related to the use of personal watercraft, motorized boats, and other visitor activities would be negligible to minor over the short and long term.

Impacts of the No-Action Alternative — No PWC Use

Analysis. An estimated 99 visitors on 67 personal watercraft were present on an average peak day in July 2002 (assuming 1.5 riders per watercraft). These visitors would no longer be allowed to participate in this form of recreation in the national recreation area. Based on current use projections, by 2012 approximately 110 PWC riders on 73 craft would not be able to enjoy this experience in the national recreation area. This alternative would prevent the park from achieving its goal of offering a wide range of recreational activities.

Impacts on PWC Users — Discontinuing PWC use would have moderate to major, short- and long-term, adverse impacts on PWC users. However, these visitors would not be precluded from experiencing the park through other recreational activities and could use other lakes in the region for PWC recreation. Nationally, approximately 68% of PWC owners previously owned powerboats (NTSB 1998). Current PWC users could still use a motorboat or other nonmotorized watercraft and could continue to hike, sightsee, and camp.

Impacts on Other Boaters — Banning PWC use within Chickasaw would eliminate interactions between other boaters and PWC operators. Other boaters would not have to watch for or come into conflict with PWC users, especially in the heavily congested launch areas, thus resulting in beneficial impacts on other watercraft users.

Impacts on Other Visitors — Restricting PWC use within the national recreation area would have beneficial impacts on other shoreline users, especially swimmers. Campers and shoreline hikers and anglers would experience more natural quiet, but would still be exposed to sounds from other motorized watercraft.

In summary, PWC operators would experience moderate to major adverse impacts, while a large number of other users would experience beneficial impacts as a result of banning PWC use.

Cumulative Impacts. The cumulative impacts for the no-action alternative would be similar to alternative A except that PWC use would not affect the experiences of other visitors. Impacts on the visitor experiences of other boaters and shoreline users would be beneficial. Conversely, the experiences of PWC users would be adversely affected to a moderate to major degree over the short and long term because of these same restrictions. On a regional basis the no-action alternative would result in a negligible to minor adverse effect to PWC activities at other waterbodies in the region as a result of PWC users going to other locations to enjoy this activity.

Conclusion. Impacts on PWC users who would no longer be able to ride in the national recreation area would be moderate to major, short and long term, and adverse. The no-action alternative would have a beneficial impact on the experiences of most other visitors because PWC use would be banned.

Cumulative impacts would be beneficial as compared to alternative A. On a regional scale the no-action alternative would result in a negligible to minor adverse effect at other waterbodies in the region as a result of PWC users going to other locations to enjoy this activity.

VISITOR CONFLICTS AND SAFETY

The National Transportation Safety Board reported that in 1996 personal watercraft represented 7.5% of state-registered recreational boats but accounted for 36% of recreational boating accidents. In the same year, PWC operators accounted for more than 41% of people injured in boating accidents. PWC operators accounted for approximately 85% of the persons injured in accidents studied in 1997 (NTSB 1998). Since PWC operators can be as young as 12 in several states, accidents can involve children. The American Academy of Pediatrics (2000) recommends that no one younger than 16 operate personal watercraft. Ten PWC accidents have been documented at Chickasaw from 1995 to 2001, most involving other boaters or PWC users, and two occurred after July 2001 (E. Cummins, NPS, pers. comm., M. Foust, NPS, July 7 and 16, 2001; S. Staples, NPS, pers. comm., D. Jones, URS, Aug. 26, 2002). Staff do not commonly receive calls for assistance in locating a PWC operator who is overdue or "missing." Rangers more often respond to accidents involving personal watercraft than overdue or missing operators, although park staff did recover one personal watercraft in 2002 that had broken down (M. Foust, NPS, pers. comm., P. Steinholtz, URS, Oct. 10, 2002). Boat patrols are conducted on a regularly scheduled basis during summer on high-use days (S. Staples, NPS, pers. comm., R. Wieland, URS, Sept. 4, 2002).

PWC speeds, wakes, and operations near other users can pose hazards and conflicts. The park has noted conflicts between PWC users and anglers. PWC users have also come into conflict with swimmers by not slowing down as required in the presence of swimmers. However, the park has not received many complaints about personal watercraft from other visitors. Diving at Chickasaw is permitted but not common due to poor visibility (M. Foust, NPS, pers. comm., P. Steinholtz, URS, Oct. 10, 2002).

GUIDING REGULATIONS AND POLICIES

In addition to the guiding regulations and policies discussed in the "Visitor Experience" section, the NPS *Management Policies 2001* state that the National Park Service is committed to providing appropriate, high-quality opportunities for visitors to enjoy the parks. The policies also state, "While recognizing that there are limitations on its capability to totally eliminate all hazards, the Service and its concessioners, contractors, and cooperators will seek to provide a safe and healthful environment for visitors and employees" (sec. 8.2.5.1). Further, the National Park Service will strive to protect human life and provide for injury-free visits (sec. 8.2.5).

Chickasaw has adopted watercraft regulations for motor vessel use at the park. These regulations apply to all motor vessel use on the reservoir. The regulations relating to PWC use at the reservoir, as stated on page 62.

The Chickasaw National Recreation Area "Superintendent's Compendium" (36 CFR, Chapter 1, revised January 2000) includes boating provisions in section 3.6 that outline speed limits, wake zones, use areas, and prohibited areas.

METHODOLOGY AND ASSUMPTIONS

The methodology for visitor conflicts and safety is similar to that used for visitor experience. The potential visitor-related impacts attributable to personal watercraft — a higher rate of accidents than for other watercraft, conflicts with other park users, negative effects on some types of visitor experiences — could potentially affect the mandate to provide for injury-free visits. Potential impacts were identified based on the number and activities of personal watercraft operating within the area, the number and activities of other visitors in an area, and the proximity of these user groups.

It is assumed that Oklahoma boating regulations are enforced within the national recreation area. These regulations govern PWC activities near the shore, the timing of use, and the age and educational requirements of operators.

IMPACT ANALYSIS AREA

The impact analysis area comprises surface waters and adjacent landing areas in Lake of the Arbuckles, including the Upper Guy Sandy and Rock Creek arms of the lake. Additionally, PWC use may affect visitors at beaches, trails, and campgrounds near the shoreline, such that visitors within 200 feet of the shore are considered to be within the affected area.

IMPACT OF PWC USE AND CONFLICTING USES ON VISITOR SAFETY

The impact intensities for both visitor conflicts and safety follow. Where impacts to visitor experience or visitor safety become moderate or minor, it is assumed that current visitor satisfaction and safety levels would begin to decline and the park would not be achieving some of its long-term visitor goals.

Negligible: The impact to visitor safety would not be measurable or perceptible.

Minor: The impact would be measurable or perceptible, but it would be limited to a relatively small number of visitors at localized areas. Impacts to visitor safety could be realized through a minor increase or decrease in the potential for visitor conflicts in current accident areas.

Moderate: The impact to visitor safety would be sufficient to cause a permanent change in accident rates at existing low accident locations or to create the potential for additional visitor conflicts in areas that currently do not exhibit noticeable visitor conflict trends.

Major: The impact to visitor safety would be substantial either through the elimination of potential hazards or the creation of new areas with a high potential for serious accidents or hazards.

Impacts of Alternative A —— Continue PWC Use under a Special Regulation

Analysis. This alternative assumes that PWC operations would continue, increasing from 66 personal watercraft on a peak summer day now to 73 by 2012.

PWC User / Swimmer Conflicts — The greatest potential for conflict with swimmers is near the boat launch areas at The Point and the Buckhorn developed area. This is where many visitors swim, and these areas include the most popular boat launches within the national recreation area. Twelve PWC-related accidents have been documented since 1995, five of which involved other boats and three of which involved other personal watercraft (the rest did not involve other visitors). However, when PWC operators fall or are thrown from their vehicles (which was the case in at least two of these accidents), the machine can continue running and documented cases describe unmanned PWC harming swimmers in Michigan and Florida (NTSB 1998).

The park has closed three areas to all vessels to protect swimmers — the Goddard Youth Camp Cove, an area surrounding The Point, and certain areas near Buckhorn. However, these closures are violated at Buckhorn and The Point when watercraft access the picnic areas, which could cause conflicts with swimmers. In addition, the park has established no-wake zones to help protect visitors, but violations do occur in all closed areas, including the Rock Creek area. By 2012 an estimated 73 personal watercraft

could be operated on peak-use days, and many of these users would likely concentrate near popular swim areas and could violate the no-wake rule when they landed, picked up passengers, or changed operators. Even though no PWC-related accidents have occurred involving a swimmer, park staff have received complaints from swimmers about PWC users not slowing down when nearby. Due to the concentration of visitors that use the boat launch areas at Buckhorn and The Point, impacts at these locations are predicted to be minor to moderate, short and long term, and adverse.

The remaining park locations would experience little or no conflict between PWC users and swimmers. There are very few swimmers in other areas of the park that are frequented by PWC use. Thus, conflicts in these segments would constitute negligible, adverse impacts over the short and long term.

PWC User / Other Boater Conflicts — Approximately 98% of all watercraft operators launch at The Point, Buckhorn, and Guy Sandy. Most watercraft users begin and end their trips at one of these three launch areas. Based on a peak use month such as July 2002, this means that approximately 4,526 total watercraft would be distributed among these three launch sites, for approximately 1,500 vessels per site. Because personal watercraft represent an estimated 20% to 30% of all vessels, the potential for incidents or accidents at congested boat ramps exists. Since 1995, 12 of 20 vessel accidents involved personal watercraft (E. Cummins, NPS, pers. comm., M. Foust, NPS, July 7 and 16, 2001; S. Staples, NPS, pers. comm., D. Jones, URS, Aug. 26, 2002). PWC users may also come into conflict with nonmotorized boaters in the no-wake areas in Upper Guy Sandy and particularly the upper areas of Rock Creek, where PWC have violated the no-wake rules.

Impacts to other boaters would be minor to moderate, short and long term, and adverse. Impacts would be concentrated at localized areas, primarily launches at The Point, Buckhorn, and Guy Sandy.

Cumulative Impacts. Lake of the Arbuckles and its shoreline are used by swimmers, motorboat users, kayakers, canoeists, campers, anglers, and hikers. All of these user groups interact with each other and occasionally come into conflict. Some user groups are more dispersed than others. For example, kayakers, canoeists, and swimmers tend to stay close to the shore, whereas PWC and motorboat operators tend to stay at least 150 feet offshore, unless landing. This separation of use reduces the potential for conflicts between the various groups. However, several user groups favor the same general location, which includes areas around The Point, the Buckhorn developed area, and Guy Sandy, and watercraft have violated no-wake rules. For this reason, the cumulative impact of the various user groups on visitor conflicts and safety would be minor to moderate and adverse over the short and long term.

Conclusion. Continued PWC use would have minor to moderate, short- and long-term, adverse impacts on visitor conflicts and safety, particularly in the areas of the launches around The Point, Buckhorn, and Guy Sandy due to the number of visitors and boats present on high-use days, as well as a concentration of conflicting uses. Conflicts at other locations would remain negligible because use is lower and conflicts would be less likely to occur.

Cumulative impacts related to visitor conflicts and safety would continue to be minor to moderate for all user groups in the short and long term, particularly near the high-use areas. Cumulative impacts in other segments would be negligible because of reduced use.

Impacts of Alternative B — Continue PWC Use under a Special Regulation with Additional Management Prescriptions

Analysis. PWC operators would be required to carry state boat registration cards. Fueling would only be allowed while the unit was trailered and away from the water surface. Some sites could be seasonally or

permanently closed as needed to protect cultural resources or threatened and endangered species. An extended no-wake zone would be established around the Buckhorn developed area. A voluntary, self-regulatory PWC user group would develop rules and guidelines for PWC use, and a new program would monitor visitor use patterns. User fees for all visitors would be increased to cover higher monitoring and enforcement costs of new restrictions and for resource management. A PWC user educational program would be established and funded by an increased user fee. User fee refunds or rate reductions would be offered for users voluntarily complying with the EPA emission standards.

PWC User / Swimmer Conflicts — Impacts would be similar to alternative A, since the number of personal watercraft operating within the recreation area would not change. Extending the no-wake zone around the Buckhorn developed area, along with continued PWC use, would result in a negligible change in visitor experiences or conflicts with swimmers. However, continued violations of the no-wake zone and an expected increase of 1% per year in PWC use at congested locations, particularly boat launches near popular swim areas, could affect swimmers in the long term. Swimmers would benefit from PWC operators having to fuel their watercraft away from the water surface. PWC rules and guidelines developed by the voluntary, self-regulatory PWC user group could also help reduce potential conflicts between PWC users and other visitors. User fees for all visitors would be increased to cover higher monitoring and enforcement costs of new restrictions, resource management, and a PWC educational program.

Based on this analysis, PWC activity at Lake of the Arbuckles would have minor adverse impacts on the experiences of swimmers. As under alternative A, swimmers at other Chickasaw locations would continue to experience negligible adverse impacts.

PWC User / Other Boater Conflicts — Impacts would be similar to alternative A. As mentioned above, PWC rules and guidelines developed by the PWC user group could help reduce potential conflicts between PWC users and other visitors. Increased user fees would cover higher monitoring and enforcement costs of new restrictions.

Overall, PWC use would continue to have minor to moderate adverse impacts on other motorized boat users at Chickasaw. Impacts would be concentrated at localized areas, primarily launches at The Point, Buckhorn, and Guy Sandy.

Cumulative Impacts. Cumulative impacts would be similar to alternative A. Lake of the Arbuckles and its shoreline are used by various visitors, all of whom interact with each other and occasionally come into conflict. Several user groups favor the same general location, which includes areas around The Point, the Buckhorn developed area, and Guy Sandy. For this reason, the cumulative impact of the various user groups on visitor conflicts and safety would be minor to moderate and adverse over the short and long term.

Conclusion. Similar to alternative A, continued PWC use would have minor to moderate, short- and long-term, adverse impacts on visitor conflicts and safety, particularly around launches at The Point, Buckhorn, and Guy Sandy, due to the concentration of conflicting uses on high-use days. Conflicts at other locations would remain negligible because conflicts would be less likely to occur.

Cumulative impacts related to visitor conflicts and safety would continue to be minor to moderate for all user groups in the short and long term, particularly near high-use areas. Cumulative impacts in other areas would be negligible because of reduced use.

Impacts of Alternative C — Continue PWC Use but Limit Area of Use and Implement Other Restrictions

Analysis. PWC use would be restricted to the main body and some arms of Lake of the Arbuckles; additional sites could be seasonally or permanently closed as needed to protect cultural resources and threatened or endangered species. Additional restrictions would include regulating the PWC carrying capacity through a day-use permit system, requiring PWC users to stay 150 feet from all shorelines (except for launch ramps and mooring areas), increasing the minimum age of operators to 16, and either restricting hours of operation or limiting use to weekends and holidays. A PWC user educational program would be established and funded by increased user fees. User fee refunds or rate reductions would be offered for PWC users who voluntarily comply with the EPA emission standards prior to 2005.

PWC User / Swimmer Conflicts — Requiring PWC users to stay 150 feet from all shorelines (except launch ramps and mooring areas) would reduce potential conflicts with swimmers, who primarily congregate near the popular boat launch areas at The Point and the Buckhorn developed area. Prohibiting PWC use in the northern section of the Upper Guy Sandy and Rock Creek arms would also benefit swimmers, particularly in Rock Creek, where PWC users have violated the existing no-wake zone. Instituting a PWC educational program and raising the age for PWC operators could help reduce these violations, and extending no-wake zones could further reduce conflicts by requiring PWC operators to go slower in more areas of the lake. Limiting the number of personal watercraft through use permits could also reduce the potential for conflicts. If a weekday restriction was established, the potential for conflicts between PWC users and swimmers would be eliminated on these days. Overall, swimmers would experience a beneficial impact under alternative C due to restrictions on PWC use.

PWC User / Other Boater Conflicts — Other boaters to Chickasaw would continue to interact with PWC operators and experience impacts similar to alternative A. However, conflicts between non-motorized boat users would be expected to decrease due to PWC closures in the northern sections of the Upper Guy Sandy and Rock Creek arms of the lake. A 150-foot buffer zone along the shoreline would also benefit canoeists and kayakers who travel the lake along the shore. As under alternative A, motorboaters would continue to be more likely to interact with PWC users, but possibly limiting use to weekends and holidays could help reduce the potential for conflicts. Limiting PWC use through a permit system could also help reduce conflicts. The most common area for personal watercraft / boater interaction is near the boat launches at Buckhorn, The Point, and Guy Sandy. Impacts to other boaters in these areas would be minor to moderate, short and long term, and adverse. Since 1995 there have been 12 vessel accidents in the recreation area involving personal watercraft, five of which were with motorized boats. Increasing the age of operators to 16 and instituting a PWC educational program could also help reduce accidents. Other boaters (nonmotorized and motorized) would experience beneficial impacts now and in the future due to PWC use restrictions.

Cumulative Impacts. Restricting PWC use, imposing additional no-wake areas, and limiting the number of personal watercraft and their hours or days of operation, as well as the age of PWC operators, would help reduce the potential for conflict and accidents involving other users. However, conflicts between other user groups would continue. The cumulative impact of the various user groups on visitor conflicts and safety would be reduced to a minor adverse impact over the short and long term.

Conclusion. Swimmers and other boaters would experience beneficial impacts under alternative C in areas where PWC use would be restricted, thus helping reduce conflicts and increase safety. Boaters in areas remaining open to PWC use would experience minor to moderate, short- and long-term, adverse impacts similar to alternative A; impacts would be concentrated at localized areas, primarily launches at The Point, Buckhorn, and Guy Sandy.

Restricting PWC use would help reduce the potential for conflict and accidents with other users, reducing the cumulative impact to minor and adverse over the short and long term.

Impacts of the No-Action Alternative — No PWC Use

Analysis. Under the no-action alternative all PWC use would be banned, eliminating any conflicts between PWC operators and other recreation area visitors. PWC users have been involved in 12 vessel accidents since 1995. Eliminating PWC operation in the national recreation area would yield a perceptible change for some visitors, particularly swimmers. No incidents would occur between swimmers or boaters and personal watercraft, resulting in beneficial impacts.

Cumulative Impacts. Cumulative impacts would be similar to those described for alternative A, except PWC use would be eliminated. Overall, conflicts and safety would improve as compared to alternative A because another source for potential conflicts between user groups would be eliminated. Conflicts between motorboat users and other non-motorized craft in summers would continue. Cumulative impacts to visitor conflict and safety would be reduced to negligible to minor adverse impacts.

Conclusion. Discontinuing PWC use would result in beneficial impacts by reducing visitor conflicts and enhancing safety.

PWC-related contributions to overall cumulative impacts to visitor safety would be eliminated; however, visitor safety impacts from other sources would continue to result in minor adverse impacts.

CULTURAL RESOURCES

GUIDING REGULATIONS AND POLICIES

The National Park Service's primary interest in these places stems from its responsibilities under the following legislation:

> *The NPS Organic Act* — responsibility to conserve the natural and historic objects within parks unimpaired for the enjoyment of future generations
>
> *National Historic Preservation Act* — responsibility to preserve, conserve, and encourage the continuation of the diverse traditional prehistoric, historic, ethnic, and folk cultural traditions that underlie and are a living expression of our American heritage
>
> *American Indian Religious Freedom Act* — responsibility to protect and preserve for American Indians access to sites, use and possession of sacred objects, and the freedom to worship through ceremonials and traditional rites
>
> *Archeological Resources Protection Act* — responsibility to secure, for the present and future benefit of the American people, the protection of archeological resources and sites that are on public lands
>
> *Executive Order 13007* — responsibility to (1) accommodate access to and ceremonial use of Indian sacred sites by Indian religious practitioners, and (2) avoid adversely affecting the physical integrity of such sacred sites.

In accordance the *Management Policies 2001*, the National Park Service must be respectful of these ethnographic resources, and carefully consider the effects that NPS actions may have on them (*Manage-*

ment Policies 2001, sec. 5.3.5.3). Specific guidance for the management of cultural resources is provided in *NPS-28: Cultural Resource Management Guideline* (NPS 1997c).

ASSUMPTIONS AND METHODOLOGIES

In this environmental assessment impacts to cultural resources (archeological resources and ethnographic resources) are described in terms of type, context, duration, and intensity, which is consistent with the CEQ regulations. These impact analyses are intended, however, to comply with the requirements of both the National Environmental Policy Act and section 106 of the National Historic Preservation Act. In accordance with the Advisory Council on Historic Preservation's regulations implementing section 106 (36 CFR Part 800, "Protection of Historic Properties"), impacts to cultural resources were identified and evaluated by

1. determining the area of potential effects
2. identifying cultural resources present in the area of potential effects that were either listed on or eligible to be listed on the National Register of Historic Places
3. applying the criteria of adverse effect to affected cultural resources either listed in or eligible to be listed on the national register
4. considering ways to avoid, minimize, or mitigate adverse effects.

Under the advisory council's regulations a determination of either adverse effect or no adverse effect must also be made for affected, national register eligible cultural resources.

> An *adverse effect* occurs whenever an impact alters, directly or indirectly, any characteristic of a cultural resource that qualify it for inclusion on the national register (e.g. diminishing the integrity of the resource's location, design, setting, materials, workmanship, feeling, or association). Adverse effects also include reasonably foreseeable effects caused by the preferred alternative that would occur later in time, be farther removed in distance or be cumulative (36 CFR 800.5, "Assessment of Adverse Effects").
>
> A determination of *no adverse effect* means there is an effect, but the effect would not diminish in any way the characteristics of the cultural resource that qualify it for inclusion on the national register.

The CEQ regulations and DO #12 also call for a discussion of the appropriateness of mitigation, as well as an analysis of how effective the mitigation would be in reducing the intensity of a potential impact (e.g. reducing the intensity of an impact from major to moderate or minor). Any resultant reduction in intensity of impact due to mitigation, however, is an estimate of the effectiveness of mitigation only under the National Environmental Policy Act. It does not suggest that the level of effect as defined by section 106 is similarly reduced. Although adverse effects under section 106 may be mitigated, the effect remains adverse.

A section 106 summary is included at the end of the analysis section and is intended to meet the requirements of the National Historic Preservation Act. It also is intended to provide an assessment of the effect of the undertaking (implementation of the alternative) on cultural resources, based on the criteria found in the advisory council's regulations.

IMPACTS ON ARCHEOLOGICAL SITES AND SUBMERGED RESOURCES

Certain important research questions about human history can only be answered by the actual physical material of cultural resources. Archeological resources have the potential to answer, in whole or in part, such research questions. An archeological site can be eligible to be listed on the National Register of Historic Places if the site has yielded, or may be likely to yield, information important in prehistory or history.

Negligible: The impact would be at the lowest levels of detection or barely measurable, with no perceptible consequences, either adverse or beneficial, to archeological resources. For purposes of section 106, the determination of effect would be *no adverse effect*.

Minor: Adverse impact — The disturbance of a site would be confined to a small area with little, if any, loss of important information potential. For purposes of section 106, the determination of effect would be *no adverse effect*.

Beneficial impact — A site would be preserved in its natural state. For purposes of section 106, the determination of effect would be *no adverse effect*.

Moderate: Adverse impact — Disturbance of a site would not result in a substantial loss of important information. For purposes of section 106, the determination of effect would be *adverse effect*.

Beneficial impact — The site would be stabilized. For purposes of section 106, the determination of effect would be *no adverse effect*.

Major: Adverse impact — Disturbance of a site would be substantial and would result in the loss of most or all of the site and its potential to yield important information. For purposes of section 106, the determination of effect would be *adverse effect*.

Beneficial impact — There would be active intervention to preserve the site. For purposes of section 106, the determination of effect would be *no adverse effect*.

Impairment: A major, adverse impact to a resource or value whose conservation is

necessary to fulfill specific purposes identified in the establishing legislation or proclamation of (park name);

key to the natural or cultural integrity of the park; or

identified as a goal in the park's general management plan or other relevant NPS planning documents

Impact Analysis Area

In terms of PWC use, the appropriate boundary for analyzing visitor experience impacts includes Lake of the Arbuckles and areas within 200 feet of the shore where PWC users may land and go ashore.

Impacts of Alternative A — Continue PWC Use under a Special NPS Regulation

Analysis. PWC users would continue to have access to archeological and submerged cultural resources under this alternative. No cultural resources are currently listed on the National Register of Historic Places, and not all identified sites have been formally evaluated.

Potential impacts directly attributable to continued PWC use are difficult to quantify. The most likely impact to archeological and submerged cultural sites would result from PWC users landing in areas otherwise inaccessible to most other park visitors and illegally collecting or damaging artifacts. According to park staff, looting and vandalism of cultural resources is not a substantial problem. A direct correlation of impacts attributed to PWC users is difficult to draw, since many of these areas are also accessible to backcountry hikers or other watercraft users. Under this alternative impacts on potentially listed archeological resources as a result of PWC use would be minor and adverse.

Continuing PWC use under a special regulation is not expected to negatively affect the overall condition of cultural resources because project-by-project inventories and mitigation would still be conducted. However, without a systematic monitoring program and given the potential access concerns, there would continue to be a risk of some unavoidable adverse impacts.

Cumulative Impacts. PWC users, other boaters, and land-based user groups would continue to have access to remote areas with potentially listed archeological sites and submerged cultural resources. On a cumulative basis all visitor activities could result in minor to moderate adverse impacts on those resources that are readily accessible, due to the number of visitors and the potential for looting and vandalism. Resources in more remote areas that are not as readily accessible to visitors would likely still experience minor adverse impacts on a cumulative basis. All impacts levels would continue at existing levels.

Conclusion. Continuing PWC use within Chickasaw could have minor adverse impacts on potentially listed archeological sites and submerged resources from possible illegal collection and vandalism.

Cumulative impacts on archeological and submerged cultural resources that are readily accessible could be minor to moderate adverse, due to the number of visitors and the potential for illegal collection or destruction.

This alternative would not result in an impairment of cultural resources.

Impacts of Alternative B — Continue PWC Use under a Special NPS Regulation with Additional Management Prescriptions

Analysis. PWC users would continue to have access to archeological and submerged cultural resources under this alternative. No cultural resources are currently listed on the National Register of Historic Places, and not all identified sites have been formally evaluated.

Potential impacts directly attributable to unrestricted PWC use are difficult to quantify. The most likely impact to archeological and submerged cultural sites would result from PWC users landing in areas otherwise inaccessible to most other national recreation area visitors and illegally collecting or damaging artifacts. According to park staff, looting and vandalism of cultural resources is not a substantial problem. As described under alternative A, a direct correlation of impacts attributed to PWC users is difficult to draw, since many of these areas are also accessible to backcountry hikers or other watercraft users. Under this alternative, there would be a PWC user group that would help with education, as well as a voluntary user education program. This would help keep PWC-related impacts to minor levels.

Continuing PWC use under a special regulation with additional prescriptions is not expected to adversely affect the overall condition of cultural resources because project-by-project inventories and mitigation would still be conducted. A systematic monitoring program with closures of areas as needed, as proposed under this alternative, would further reduce the impact severity.

Cumulative Impacts. Cumulative impacts would be the same as those described for alternative A. PWC users, other boaters, and land-based user groups would continue to have access to remote areas with potentially listed archeological sites and submerged cultural resources, with minor to moderate adverse impacts on those resources that are readily accessible, due to the number of visitors and the potential for looting and vandalism. Resources in more remote areas would likely still experience minor adverse impacts on a cumulative basis. All impacts levels would continue at existing levels.

Conclusion. Continuing PWC use within Chickasaw could have minor adverse impacts on potentially listed archeological sites and submerged resources from possible illegal collection and vandalism, similar to alternative A. Closure of some areas and provisions for monitoring would lessen the likelihood of adverse effects related to PWC use.

Cumulative impacts on archeological and submerged cultural resources that are readily accessible could be minor to moderate adverse, due to the number of visitors and the potential for illegal collection or destruction.

This alternative would not result in an impairment of cultural resources.

Impacts of Alternative C — Continue PWC Use under a Special NPS Regulation but Limit Area of Use and Implement Other Restrictions

Analysis. PWC users would continue to have access to archeological and submerged cultural resources under this alternative, although the areas they can access would be reduced. No cultural resources are currently listed on the National Register of Historic Places, and not all identified sites have been formally evaluated.

Impacts would be similar to those described under alternative A. However, closing the Upper Guy Sandy and Rock Creek arms of the lake, expanding the no-wake zone adjacent to the Buckhorn developed area, and prohibiting PWC use within 150 feet of all shorelines (except launching areas) would tend to lessen the impacts caused by wake action and from landing in these areas. Proposals to increase enforcement and to develop a self-regulated user group, plus a mandatory user education program, could further help reduce these types of impacts. Overall, the number of PWC users expected within the park would have only minor adverse impacts on potentially listed archeological resources under alternative C.

Continuing PWC use under a special regulation with limited use areas and other restrictions is not expected to adversely affect the overall condition of cultural resources because project-by-project inventories and mitigation would still be conducted. A systematic monitoring program with closures of areas as needed would further reduce the impact severity.

Cumulative Impacts. PWC users, other boaters, and land-based user groups would continue to have access to remote areas with potentially listed archeological sites and submerged cultural resources. On a cumulative basis all visitor activities could result in minor to moderate adverse impacts on those resources that are readily accessible, due to the number of visitors and the potential for looting and vandalism. Resources in more remote areas that are not as readily accessible to visitors would likely still experience minor adverse impacts on a cumulative basis, but to a lesser degree. All impact levels would continue at existing levels.

Conclusion. Continuing PWC use could have minor adverse impacts on potentially listed archeological sites and submerged resources from possible illegal collection and vandalism, similar to alternative A.

Closing some areas to use and providing for monitoring would lessen the likelihood of adverse effects related to PWC use.

Cumulative impacts on archeological and submerged cultural resources that are readily accessible could be minor to moderate adverse, due to the number of visitors and the potential for illegal collection or destruction.

This alternative would not result in an impairment of cultural resources.

Impacts of the No-Action Alternative — No PWC Use

Analysis. Under this alternative PWC use would be discontinued, resulting in minor beneficial impacts on archeological sites and submerged cultural resources by reducing the potential for illegal collection or damage attributable to PWC users.

Cumulative Impacts. Even without the potential for PWC users to access remote areas, the effects of other watercraft users and land-based user groups would still have the potential for minor to moderate adverse cumulative impacts. On a cumulative basis potential visitor impacts from illegally collecting or damaging resources that are readily accessible would continue. Resources in more remote areas would likely still experience minor adverse impacts.

Conclusion. Prohibiting PWC use would have minor beneficial impacts on archeological sites and submerged resources by reducing the potential for illegal collection or damage attributable to PWC users.

Cumulative impacts from all visitor activities would continue to be minor to moderate, depending on the accessibility of the resource and the potential for illegal collection or damage.

This alternative would not result in an impairment of cultural resources.

IMPACTS ON ETHNOGRAPHIC RESOURCES

Appropriate Native American tribes were contacted and no concerns have been expressed regarding PWC use at Lake of the Arbuckles. An ethnographic study of the Platt District has been initiated and that portion of the national recreation area is a significant ethnographic resource (Wray and Roberts 2001). However, it would appear that the activity areas in the Platt District are far enough from the lake so as not to be influenced by PWC use. A specific survey for ethnographic resources in the Lake of the Arbuckles District has not been undertaken, but no specific concerns about this area have been expressed.

Certain important questions about human culture and history can only be answered by gathering information about the cultural content and context of cultural resources. Questions about contemporary peoples or groups, their identity, and heritage have the potential to be addressed through ethnographic resources. As defined in *NPS-28: Cultural Resource Management Guideline,* an ethnographic resource is a site, structure, object, landscape, or natural resource feature assigned traditional legendary, religious, subsistence, or other significance in the cultural system of a group traditionally associated with it. Some such specific places of traditional cultural use may be eligible for inclusion on the National Register of Historic Places if they meet criteria for traditional cultural properties. For purposes of analyzing potential impacts to ethnographic resources, the thresholds of change for the intensity of an impact are defined below:

Negligible: The impact would be barely perceptible and would neither alter resource conditions, such as traditional access or site preservation, nor the relationship between the resource and the affiliated group's body of beliefs and practices. There would be no change to a group's body of beliefs and practices. For purposes of section 106, the determination of effect would be *no adverse effect.*

Minor: Adverse impact — The impact would be slight but noticeable and would neither appreciably alter resource conditions, such as traditional access or site preservation, nor the relationship between the resource and the affiliated group's body of beliefs and practices. For purposes of section 106, the determination of effect would be *no adverse effect.*

Beneficial impact — The action would allow traditional access and/or accommodate a group's traditional practices or beliefs. For purposes of section 106, the determination of effect would be *no adverse effect.*

Moderate: Adverse impact — The impact would be apparent and would alter resource conditions. Something would interfere with traditional access, site preservation, or the relationship between the resource and the affiliated group's beliefs and practices, even though the group's beliefs and practices would survive. For purposes of section 106, the determination of effect would be *adverse effect*.

Beneficial impact — The action would facilitate a group's beliefs and practices. For purposes of section 106, the determination of effect would be *no adverse effect.*

Major: Adverse impact — The impact would alter resource conditions. Something would block or greatly affect traditional access, site preservation, or the relationship between the resource and the affiliated group's body of beliefs and practices, to the extent that the survival of a group's beliefs and/or practices would be jeopardized. For purposes of section 106, the determination of effect would be *adverse effect.*

Beneficial impact — The action would encourage a group's beliefs or practices. For purposes of section 106, the determination of effect would be *no adverse effect.*

Impairment: A major, adverse impact to a resource or value whose conservation is

necessary to fulfill specific purposes identified in the establishing legislation or proclamation of (park name);

key to the natural or cultural integrity of the park; or

identified as a goal in the park's general management plan or other relevant NPS planning documents.

Impact Analysis Area

The impact analysis area for ethnographic resources is related to the area of PWC use and the distance that PWC noise travels. PWC noise can travel inland and is expected to dissipate significantly within 0.75 mile of the source. Thus, the impact analysis area is the lake shoreline and 0.75 mile inland.

Impacts of Alternative A — Continue PWC Use under a Special NPS Regulation

Analysis. While ethnographic resources have not yet been formally evaluated for their status as traditional cultural properties / sacred sites, traditional uses of the Sulphur Springs area indicate the need for

visitors to show reverence and respect. If ethnographic resources were identified along the shore of Lake of the Arbuckles, PWC noise level and pitch changes, caused by rapid acceleration, deceleration, and change of direction, could disturb traditional users of these areas and detract from their enjoyment and use. The often brightly colored personal watercraft, flotation devices, and wetsuits could constitute a visual intrusion. In addition, PWC users could land along the shoreline and inadvertently intrude on ceremonies being conducted at sacred sites.

Because ethnographic resources are not known to be present in the Lake of the Arbuckles District, it is assumed that continuing PWC use would not adversely affect any resources, and there would be no impacts on ethnographic resources or their traditional use. If ethnographic sites were identified in the future, the park would take appropriate action to protect sites and traditional uses from adverse effects related to PWC use.

Cumulative Impacts. Because no ethnographic resources have been identified around Lake of the Arbuckles, this alternative would not contribute to any cumulative effects on such resources.

Conclusion. This alternative would not impact any known ethnographic resources or traditional use areas along the shoreline of Lake of the Arbuckles.

No cumulative impacts have been identified.

This alternative would not impair ethnographic resources.

Impacts of Alternative B — Continue PWC Use under a Special NPS Regulation with Management Restrictions

Analysis. As described for alternative A, no ethnographic resources are known in the Lake of the Arbuckles District, and continuing PWC use would not adversely affect any such resources. If ethnographic sites were identified in the future, the park would take appropriate action to protect sites and traditional uses from adverse effects related to PWC use.

Cumulative Impacts. This alternative would not contribute to any cumulative effects on such resources.

Conclusion. This alternative would not impact any known ethnographic resources or traditional use areas along the shoreline of Lake of the Arbuckles.

No cumulative impacts have been identified.

This alternative would not impair ethnographic resources.

Impacts of Alternative C — Continue PWC Use under a Special NPS Regulation but Limit Area of Use and Implement Other Restrictions

Analysis. Under alternative C PWC use would be prohibited within 150 feet of the shoreline (except for launching areas). This would help reduce any possible impact as a result of noise or visual intrusions related to PWC use. Further, PWC users would not have access to most of the shoreline, reducing any potential for them to land and inadvertently intrude on ceremonies. As described for alternative A, no ethnographic resources are known in the Lake of the Arbuckles District, and continuing PWC use would not adversely affect any such resources.

Cumulative Impacts. This alternative would not contribute to any cumulative effects on such resources.

Conclusion. This alternative would not impact any known ethnographic resources or traditional use areas along the shoreline of Lake of the Arbuckles.

No cumulative impacts have been identified.

This alternative would not impair ethnographic resources.

Impacts of the No-Action Alternative — No PWC Use

Analysis. As described for alternative A, no ethnographic resources are known in the Lake of the Arbuckles District. Banning PWC use would have beneficial impacts as a result of preventing any possible intrusion on ethnographic resources or their traditional uses along the shoreline of Lake of the Arbuckles.

Cumulative Impacts. This alternative would not contribute to any cumulative effects on such resources.

Conclusion. Banning PWC use would remove any possible intrusions on ethnographic resources or traditional uses as a result of PWC use. This would be a beneficial impact.

No cumulative impacts have been identified.

This alternative would not impair ethnographic resources.

SECTION 106 SUMMARY

This environmental assessment provides detailed descriptions of four alternatives (including the no-action alternative), and it analyzes the potential impacts associated with possible implementation of each alternative. The analysis of potential impacts of personal watercraft at Chickasaw National Recreation Area also considered access by other types of watercraft.

Visitors access areas of the recreation area by many modes of transportation, including motor vehicles and all types of motorized watercraft (including personal watercraft), as well as by foot. Because of the diverse modes of access, the impacts on archeological and submerged cultural resources and ethnographic resources directly attributable to PWC use are difficult to define. Under alternatives A and B, PWC users could cause minor adverse impacts as a result of possible illegal collection and vandalism of archeological resources within the national recreation area that are listed on or eligible to be listed on the National Register of Historic Places.

Under alternatives B and C the introduction of a user education program could also reduce some of the potential for illegal collection or destruction.

The continuation of traditional Native American religious activities is crucial to the preservation of tribal cultural values and identity. Visitors using personal watercraft, as well as other means of transport, could deliberately or unknowingly intrude on ceremonial activities or disturb resources and archeological sites valued by tribes. No ethnographic resources are known along the shoreline of Lake of the Arbuckles, so no inadvertent disturbance of these resources or traditional uses is expected. Over the long term PWC

noise could be reduced as a result of quieter engine technologies, resulting in short-term, negligible to minor, adverse impacts (no adverse effects) if traditional uses were occurring.

To help reduce the potential for impacts, cultural resources would continue to be monitored. Vulnerable resources listed on or potentially eligible for listing on the National Register of Historic Places would have priority for protective measures, and NPS staff would continue to actively work with tribes to protect ethnographic resources and privacy for traditional activities. If ethnographic sites were identified in the future, the park would take appropriate action to protect sites and traditional uses from adverse effects related to PWC use.

In cases where it was determined there was a potential for adverse impacts (as defined in 36 CFR 800) to cultural resources listed on or eligible for listing on the National Register of Historic Places, the National Park Service would coordinate with the state historic preservation officer to determine the level of effect on the property, and the needed mitigation measures.

Pursuant to 36 CFR 800.5 (revised regulations effective January 2001), the National Park Service finds that the implementation of any PWC management alternative at Chickasaw National Recreation Area, with identified mitigation measures, would not result in any new adverse effects (no adverse effect) to cultural resources currently identified as eligible for or listed on the National Register of Historic Places.

SOCIOECONOMIC EFFECTS

This section summarizes the socioeconomic impacts associated with the proposed alternatives for PWC use in Chickasaw. A detailed description of these impacts and a complete list of references is provided in the "Economic Analysis of Personal Watercraft Regulations in Chickasaw National Recreation Area" (Law et al. 2002). The following briefly summarizes those effects.

The primary economic impacts associated with the proposed PWC restrictions would be potential reductions in the sales, profits, and employment of businesses that serve PWC users visiting the park. The total regulatory cost of each alternative would depend on how the affected individuals and firms responded to changes under alternative C or the no-action alternative. To the extent that affected local retailers could provide substitute products and services, they might be able to reduce any negative impact on their profits. For instance, some current PWC users might continue to visit the park to participate in other recreational activities, which would decrease the financial impact on local businesses. It is also possible that visitation by non-PWC users to the national recreation area would increase following restrictions on PWC use if the restrictions made park visitation more enjoyable for other users.

BENEFIT-COST ANALYSIS

The purpose of benefit-cost analysis is to determine whether an alternative would promote an efficient allocation of resources; that is, whether the proposed action would generate more benefits than costs. These costs and benefits accrue directly to households that use personal watercraft, and indirectly to those who are affected by PWC use (e.g., those who would benefit from reduced noise). The resulting changes in PWC use could also impose costs on those who own or work for PWC-related businesses.

Even individuals who do not visit this national recreation area could benefit from the knowledge that resources were being protected and preserved. Evidence of "nonuse" values for resources like Chickasaw has been established in the economics literature (Pearce and Moran 1994). Restrictions on PWC use could

therefore provide benefits to both users and nonusers by protecting the national recreation area's ecological and other resources.

Under alternatives A and B there would be no change in welfare for any users relative to current conditions because personal watercraft would continue be allowed. Extending the no-wake zone around the Buckhorn developed area under alternative B would not change current conditions. Local and regional economic impacts related to PWC use are not measurable.

Alternative C would benefit all users except PWC operators and those businesses involved with PWC sales and service. Restricting PWC use to the main body of the lake and not allowing use in the current no-wake zones in the Guy Sandy arm and the Rock Creek arm (and extending that no-use zone to just north of The Point campground) could have beneficial impacts, but the degree would be ambiguous because of the potential for congestion in areas still open to PWC use (Law et al. 2002). Adverse effects to swimmers, anglers, canoeists, and other boaters would be reduced under alternative C due to greater spatial restrictions.

The no-action alternative would have a beneficial effect for all users except PWC users and PWC-related businesses, although the magnitude of the change would be larger under this alternative than under alternative C. Although recreationists could continue to use personal watercraft outside the unit by trailering them to other locations, they would likely experience large reductions in welfare. Similar to alternative C, the impact on boaters would most likely be beneficial, but this could be offset by the potential for increased congestion in waters at substitute areas such as Lake Murray and Lake Norman. Adverse effects to swimmers, anglers, canoeists, and other boaters who use the park would be greatly reduced under the no-action alternative as a result of prohibiting PWC use within park boundaries.

COSTS TO PWC USERS

Two groups of PWC riders could be affected by the proposed regulations: those who currently ride in Chickasaw and those who use personal watercraft in areas outside the park where displaced riders could go if PWC use at Chickasaw was restricted.

For PWC users who currently ride at Chickasaw or who want to ride in the park in the future, prohibiting or restricting PWC use in the park could result in consumer surplus losses, an adverse effect. Under alternative C the requirement that personal watercraft would have to meet the EPA emission standards by 2005 would have a moderate to major adverse impact to PWC users by requiring them to purchase newer models. To the extent that individuals used other nearby areas for PWC recreation, the adverse impact would be reduced.

PWC users who currently ride in nearby areas and were displaced by riders from the national recreation area would be adversely affected if these areas subsequently became more crowded. Although no studies are available that examine the impact of congestion on the value of a PWC trip, other recreation demand studies find that congestion lowers the value of a recreational experience.

Under alternatives A and B PWC riders would remain unaffected. Extending the no-wake zone around the Buckhorn developed area under alternative B would result in a negligible impact.

Under alternatives C only PWC users who ride at Chickasaw would be affected because they would be restricted to using the main body of the lake and some arms. There could be an increase in congestion, adversely affecting PWC users who currently ride in the area. Overall, negligible to minor adverse impacts are expected under alternative C.

Banning PWC use under the no-action alternative would have a major, short- and long-term, adverse effect on PWC users in the national recreation area. They could trailer their watercraft to other use areas, but it would be far more inconvenient and expensive.

COSTS TO LOCAL AREA BUSINESSES

Based on current information, it is not possible to quantify the magnitude of the impacts that PWC use restrictions would have on local PWC retailers and service providers. If PWC use decreased as a result of use restrictions, then the suppliers of PWC accessories and storage would be adversely affected. Lodging establishments, restaurants, gas stations, and other businesses that serve PWC riders would be unlikely to experience a substantial reduction in business from any proposed restriction because PWC users at Chickasaw are believed to be primarily day users and because PWC users account for a very small share of total visitation to the area. Impacts on the local and regional economies related to PWC use are not measurable.

NATIONAL RECREATION AREA MANAGEMENT AND OPERATIONS

CONFLICT WITH STATE AND LOCAL PWC ORDINANCES AND POLICIES

Some states and local governments have taken action, or are considering taking action, to limit, ban, and otherwise manage PWC use. While a national park system unit may be exempt from these local actions, consistency with state and local plans must be evaluated in accordance with the National Environmental Policy Act.

Oklahoma has passed the Oklahoma Boating Safety Regulation Act, which is implemented by the Oklahoma Department of Public Safety. This act regulates all motor vessel use within the state. The National Park Service has jurisdiction over the surface water within the Chickasaw boundary. Under the provisions of memorandums of understanding, the state of Oklahoma, the Murray County Sheriff's Department, the Sulphur Police Department, and the Sulphur Fire Department also patrol the Lake of the Arbuckles shoreline to enforce boating regulations and provide law enforcement assistance to the National Park Service. There are no local regulations that affect PWC operations within the national recreation area.

Impacts related to conflicts with state and local ordinances have been analyzed qualitatively using professional judgment to define thresholds or impact magnitude.

Impacts of Alternative A — Continue PWC Use under a Special Regulation

Analysis. PWC users at the national recreation area would be required to follow all applicable state regulations, as well as NPS regulations. Under this alternative NPS rangers would enforce all state regulations within the recreation area, and there would be no conflicts between NPS regulations and state or local regulations. Impacts for alternative A would be negligible since no conflicts with state regulations would occur.

Cumulative Impacts. Personal watercraft are not prohibited at any location under this alternative. Alternative A would not be in conflict with existing policies or state regulations, and cumulative impacts would be negligible.

Conclusion. State PWC regulations would continue to be enforced within the national recreation area, along with NPS regulations. Continued PWC use under alternative A would not result in conflicts with state or local regulations. Therefore, impacts (including cumulative impacts) would be negligible.

Impacts of Alternative B — Continue PWC Use under a Special Regulation with Additional Management Prescriptions

Analysis. PWC use under alternative B would be managed under current state regulations. Actions related to enforcement, monitoring and sampling, fees, consultation, and education would be more restrictive than state PWC regulations, but they would not conflict with state provisions or jurisdiction. Therefore, impacts related to conflicts with federal, state, or local requirements or policies would be negligible.

Cumulative Impacts. Alternative B would not conflict with state or local regulations or policies. Use restrictions would apply only within the national recreation area's jurisdictional boundary. Impacts related to conflicts between federal and state or local requirements or policies would be negligible.

Conclusion. PWC use restrictions under alternative B would apply only within the recreation area and would not result in conflicts with state or local PWC regulations or policies. Impacts (including cumulative impacts) related to conflicts with federal or state requirements or policies would be negligible.

Impacts of Alternative C — Continue PWC Use but Limit Area of Use and Implement Other Restrictions

Analysis. PWC use under alternative C would be managed under current state regulations, except PWC use would generally be prohibited within 150 feet of the shoreline (except for launching ramps and designated mooring areas) and in the Guy Sandy arm no-wake zone and the Rock Creek arm no-wake zone (from just north of The Point campground). These restrictions are within the National Park Service's authority to regulate activities at the national recreation area. Additional actions related to time and age restrictions, insurance requirements, enforcement, monitoring and sampling, fees, consultation, and education would be more restrictive than state PWC regulations, but they would not be in conflict with state provisions or jurisdiction. Therefore, impacts related to conflicts between federal and state or local requirements or policies would be negligible.

Cumulative Impacts. Alternative C would not conflict with existing regulations or policies. Use restrictions would apply only within the national recreation area, and no conflicts between federal and state or local regulations or policies are anticipated. Impacts related to conflicts between federal and state or local requirements or policies would be negligible.

Conclusion. PWC use restrictions under alternative C would apply only within the national recreation area and would not result in conflicts with state or local PWC regulations or policies. Impacts (including cumulative effects) related to conflicts between federal and state pr local requirements or policies would be negligible.

Impacts of No-Action Alternative — No PWC Use

Analysis. The no-action alternative would ban PWC use within the national recreation area. The National Park Service has the right to regulate the types of activities that take place under its jurisdiction. State boating regulations do not have provisions that would forbid additional controls or bans on PWC use, thus

banning PWC use would not be in conflict with state regulations or policies. The no-action alternative would not be in conflict with federal or state regulations or polices, and conflicts would be negligible.

Cumulative Impacts. There are currently no prohibited landing locations at Chickasaw. Other areas in the vicinity of the national recreation area are subject to state PWC regulations. The no-action alternative would not be in conflict with state regulations or policies. Cumulative impacts relating to regulation conflicts would be negligible.

Conclusion. Discontinuing PWC use within the national recreation area would not result in conflict with state PWC regulations or policies. There are no local PWC regulations. Therefore, impacts related to such conflicts (including cumulative impacts) would be negligible.

IMPACT TO PARK OPERATIONS FROM INCREASED ENFORCEMENT NEEDS

Director's Order #9: Law Enforcement Program (NPS 2000a), in conjunction with *Reference Manual 9: Law Enforcement,* establishes and defines standards and procedures for NPS law enforcement. Along with education and resource management, law enforcement is an important tool in achieving this mission. Commissioned rangers perform resource stewardship, education, and visitor use management activities, including law enforcement. They provide for tranquil, sustainable use and enjoyment of park resources while simultaneously protecting these resources from all forms of degradation. The objectives of the law enforcement program are to (1) prevent criminal activities through resource education, public safety efforts, and deterrence, (2) detect and investigate criminal activity, and (3) apprehend and successfully prosecute criminal violators.

Impacts to park operations from increased enforcement needs have been analyzed qualitatively using professional judgment to define thresholds or impact magnitude.

Impacts of Alternative A — Continue PWC Use under a Special Regulation

Analysis. Continuing PWC use within the national recreation area would require education and enforcement by NPS staff. This could be completed using the existing boat patrols, with the anticipation that PWC users would sometimes operate illegally within the recreation area (such as violating no-wake zones). To provide more control of PWC operations, one additional permanent ranger would be required, as well as equipment and boat patrol needs, such as fuel, oil, and maintenance supplies.

Cumulative Impacts. Motorboat users, swimmers, PWC operators, sea kayakers and canoeists all use the reservoir shoreline. NPS staff would continue to provide assistance to these user groups to resolve conflicts and ensure safety. There would be no change in park operations and enforcement needs for these groups since the number of people and boats would not change under this alternative. Current staffing levels and boat patrol frequency are not adequate to enforce existing regulations. One additional permanent staff member and additional equipment and boat patrol supplies would be required to meet existing and future (2012) needs. The staffing requirements to implement the PWC restrictions would be adequate for handling cumulative impacts related to park operations.

Conclusion. Continuing PWC use would have moderate adverse impacts on park operations. One additional permanent ranger, plus more funding and equipment, would be needed to regulate existing PWC as well as boating use.

Impacts of Alternative B — Continue PWC Use under a Special Regulation with Additional Management Prescriptions

Analysis. Continuing PWC use within the recreation area, with management actions such as increased enforcement, monitoring and sampling, fees, consultation, and education, would add to present staff duties. To provide more control of PWC operations, the park would require additional resources as described under alternative A (one additional permanent ranger, equipment, and maintenance supplies), plus funds to print and distribute PWC-specific rules and safety information as part of the voluntary PWC educational program described for this alternative (S. Staples, NPS, pers. comm., R. Wieland, URS, Oct. 7, 2002).

Cumulative Impacts. Cumulative impacts would be similar to those described for alternative A. One additional permanent staff, equipment, and boat patrol supplies would be required to meet existing and future (2012) needs. The staffing requirements to implement the PWC restrictions would be adequate for handling cumulative impacts related to park operations.

Conclusion. Similar to alternative A, this alternative would have moderate adverse impacts on park operations. One additional permanent ranger, plus more funding, equipment, and educational supplies, would be needed to ensure full compliance with PWC management prescriptions included in this alternative.

Impacts of Alternative C — Continue PWC Use but Limit Area of Use and Implement Other Restrictions

Analysis. Continuing PWC use within the recreation area with location restrictions (prohibiting PWC within 150 feet of the shoreline and closing certain arms to PWC use) and management prescriptions (related to time and age restrictions, insurance requirements, enforcement, monitoring and sampling, fees, consultation, and education) would require increased education and enforcement actions by NPS staff. Signs would be posted at the restricted areas to indicate PWC location restrictions. Additional enforcement actions would be required to monitor areas closed to personal watercraft, as well as implementation of the EPA emission standards by April 15, 2005. To provide more control of PWC operations, the park would require the same additional resources as described under alternative A, plus two additional seasonal visitor use assistants to help provide information and monitoring activities, and additional funding to outfit these assistants (S. Staples, NPS, pers. comm., R. Wieland, URS, Oct. 7, 2002).

Cumulative Impacts. Cumulative impacts would be similar to those described for alternative A. One additional permanent staff member, and additional equipment and boat patrol supplies, would be required to meet existing and future (2012) needs. The staffing requirements to implement the PWC restrictions would be adequate for handling cumulative impacts related to park operations.

Conclusion. Similar to alternative A, this alternative would have moderate adverse impacts on park operations. One permanent ranger and two part-time visitor use assistants, along with more funding, equipment, and educational supplies, would be needed to ensure full compliance with PWC location restrictions and management prescriptions included as a part of this alternative.

Impacts of No-Action Alternative — No PWC Use

Analysis. Prohibiting PWC operation within Chickasaw would eliminate potential conflicts between PWC recreationists and other user groups, but NPS staff would have to initially increase visitor education and enforcement programs to ensure that visitors understood the regulation. Signs and information

programs explaining why PWC use was not allowed would be provided at the existing launch areas (S. Staples, NPS, pers. comm., R. Wieland, URS, Oct. 7, 2002). Other park user fees might have to be increased to cover lost revenue from PWC permits, or services might have to be reduced. It is not anticipated that additional staff would be needed under this alternative.

Cumulative Impacts. Cumulative impacts would be similar to alternative A. However, with a ban on PWC use, the park does not expect increased staff or equipment would be needed. Enforcement would be conducted with present staff and boat patrols.

Conclusion. This alternative would have negligible adverse impacts on park operations. No additional staff, funding, or equipment would be needed to ensure compliance with the PWC ban or to regulate existing boating use, although staff might initially have to spend more time and effort educating visitors until they became fully aware of the PWC ban.

UNAVOIDABLE ADVERSE IMPACTS

Unavoidable adverse impacts are impacts that cannot be avoided and cannot be mitigated, and therefore would remain throughout the duration of the action. The following list describes potential adverse impacts related to the alternatives being considered:

- PWC use would continue to cause pollutant emissions into lake water and air under alternatives A, B, and C. These impacts would decrease in the long term due to the required improvements in engine emission technology. Under alternative C the park would require all personal watercraft to meet EPA emission standards by 2005, resulting in an earlier reduction of emission levels within the park.
- PWC use and landing along the shoreline under alternatives A and B would have adverse impacts on the recreation area's natural soundscape and could occasionally cause flight response in wildlife that are present along the shore.
- Shoreline vegetation could be adversely affected by PWC users landing their craft under alternatives A and B and walking along the shore. These impacts would not be noticeable and would not cause long-term changes in vegetation.
- Continued PWC use within the recreation area boundary under alternatives A, B, and C would have adverse impacts on the experiences of other visitors as a result of occasional noise and visual intrusions. Under the no-action alternative, the small number of PWC users who could no longer ride within the national recreation area would be adversely affected.
- Continued PWC use under alternatives A, B, and C could result in minor impacts to potentially listed cultural resources and ethnographic sites by providing additional access and the potential for illegal collection and vandalism, destruction, or disruption of activities related to ethnographic resources.

LOSS IN LONG-TERM AVAILABILITY OR PRODUCTIVITY TO ACHIEVE SHORT-TERM GAIN

As noted above, some resources would be degraded to some extent through implementation of either alternative A, B, or C. The only resource with potential long-term loss would be archeological or sub-merged cultural resources that could be affected by illegal collection or vandalism.

IRREVERSIBLE OR IRRETRIEVABLE COMMITMENTS OF RESOURCES

Irretrievable commitments of resources are those that can be reversed, that is, the commitment of a renewable resource or the short-term commitment of any resource. These include the commitment of water quality and air quality by allowing all mobile sources desiring to do so, including personal watercraft, to continue using the national recreation area under alternatives A, B, and C. The use of fossil fuels to power personal watercraft would be an irretrievable commitment of this resource; however, this use is minor.

CONSULTATION AND COORDINATION

Chickasaw held three public meetings as part of the public involvement process to receive input on the regulation of personal watercraft. Meetings were held on Wednesday, May 1, and Saturday, May 4, 2002, at the Travertine Nature Center in the recreation area. The third meeting was held at the Post Office Courthouse in downtown Oklahoma City on Tuesday, May 7, 2002. Nineteen individuals attended the meetings, and the park received over 100 responses by phone, correspondence, and e-mail. All requesters received copies of the preliminary draft alternatives.

Meeting attendees were given the opportunity to write comments on index cards. Out of a total of 12 responses, 3 thought personal watercraft should be banned, and 2 had quit coming to the national recreation area or limited their visits to areas where personal watercraft were prohibited for safety reasons. One person felt that banning personal watercraft for safety reasons or enforcing day and time restrictions was appropriate.

Eight commenters wanted PWC use to continue with restrictions including:

- An age limit for operators
- Educational programs on safe operation of vessels
- Limit the hours and days of use
- Limit distance from other visitors to 150’ away
- Four-stroke engines only
- Increase fees to cover costs
- Increase fees for violations
- Enforce alcohol ban
- Increase wake zones for swimming and fishing
- Limit annual permits to those operators on the Murray County tax records

CONSULTATION WITH AMERICAN INDIAN TRIBES

Letters requesting comments about PWC use were sent on September 26, 2002, to the following tribes:

- Apache Tribe of Oklahoma
- Caddo Tribal Council
- Chickasaw Nation
- Choctaw Nation of Oklahoma
- Comanche Tribal Business Com.
- Pawnee Business Council
- Wichita Executive Committee

To date no comments have been received.

CONSULTATION WITH OTHER AGENCIES

In accordance with the Endangered Species Act, the U.S. Fish and Wildlife Service was consulted about the presence of threatened, endangered, and candidate species, as well as species of concern within the area of PWC use in Chickasaw National Recreation Area. Their response is included in appendix C. The Oklahoma Department of Wildlife Conservation was also contacted to determine if state listed rare species and unique natural features are present in the area of PWC use, and their response is also included in appendix C.

Both the Oklahoma Historical Society and the Oklahoma Archeological Survey were contacted to inform them of the environmental assessment. Responses from both agencies are included in appendix C. A copy of this environmental assessment will be provided to the Oklahoma State Historic Preservation Office for final review and comment.

APPENDIX A: SUPERINTENDENT'S COMPENDIUM

DESIGNATIONS, CLOSURES, PERMIT REQUIREMENTS, AND OTHER RESTRICTIONS IMPOSED UNDER DISCRETIONARY AUTHORITY.

Revised October 23, 2002

In accordance with regulations and the delegated authority provided in Title 36, *Code of Federal Regulations* (36 CFR), Chapter 1, Parts 1-7, authorized by Title 16, *United States Code,* Section 3, the following regulatory provisions are established for the proper management, protection, government and public use of those portions of Chickasaw National Recreation Area under the jurisdiction of the National Park Service. Unless otherwise stated, these regulatory provisions apply in addition to the requirements contained in 36 CFR, Chapter 1, Parts 1–7.

Standard definitions for certain terms may be found in 36 CFR §1.4

I. 36 CFR §1.5 — VISITING HOURS, PUBLIC USE LIMITS, CLOSURES, AND AREA DESIGNATIONS FOR SPECIFIC USE OR ACTIVITIES

(a)(1) b. The area known as Goddard Youth Camp is closed to visitor use except as outlined in a memorandum of understanding between Goddard Foundation and Chickasaw National Recreation Area.

(a)(2) The following areas have been designated for a specific use or activity, under the conditions and/or restrictions as noted:

a. Camping

   i. In the interest of visitor safety and protection, all campgrounds within the National Recreation Area are closed to non-camper use and non-camper vehicle traffic between the hours of 10 p.m. and 6 a.m.

   ii. Please refer to §2.10 of this compendium for specific camping area designations.

b. Wakeless Areas:

   i. These conditions are established to protect the lives of boaters and swimmers.

   ii. Please refer to § 3.6 of this compendium for specific "No Wake" areas.

c. No Boating Areas:

   i. These conditions are established to protect the lives of boaters and swimmers.

   ii. Please refer to the map of Chickasaw National Recreation Area in the park's main brochure, which depicts the following closures that are marked by "No Boat" buoys:

   - The area around The Point Picnic Area (also known as "The End of 110")
   - Two areas near the Buckhorn Picnic Area and the Buckhorn Campground

d. Water Skiing/Towing Areas:

   i. These conditions are established to protect the lives of skiers and boaters.

   ii Please refer to §3.20 of this compendium for specific Water Skiing designations.

e. Swimming and Bathing:

   i. Swimming from boat docks, fishing docks, and on boat launching ramps is prohibited on Lake of the Arbuckles and Veterans Lake

   ii. Swimming or wading in Bromide Pavilion Lily Pond, 12th Street Fountain, Vendome Fountain, and on the roadway at Sycamore Crossing is prohibited.

iii. Please refer to §3.21 of this compendium for specific swimming and bathing designations.

f. Personal Watercraft Use Areas:

i. All lakes 100 acres or less are closed to PWC use, including Veterans Lake.

ii. Pending environmental analysis and further study, the Lake of the Arbuckles is open to PWC use in all areas open to boats. A United States District Court Judge has given Chickasaw National Recreation Area until November 6, 2002 to promulgate a specific regulation regarding PWC use. If the environmental assessment and subsequent decision-making process have not been completed by November 6, 2002, the area will be closed to PWC use until a specific rule can be promulgated. This means that the decision-making process will continue while the area is closed to PWCs after November 6, 2002.

iii. Please refer to §3.6 of this compendium for specific Personal Watercraft and other boating designations.

III. GENERAL REGULATIONS

36 CFR §2.3 — FISHING

(a) Fishing is prohibited in the following areas:

- The buffalo pasture pond
- Travertine Creek and other bodies of water east of the Travertine Nature Center in the area known as the Environmental Study Area.

Fishing in Veterans Lake and all small watershed lakes, less than 100 acres, is restricted to the use of a handline or rod and reel. Methods such as trotlines, yo yo's, sail lines, jug lines, nets, and other means of fishing are prohibited, except at Arbuckle Lake.

36 CFR §7.50 specifically authorizes fishing at Veteran's Lake and Arbuckle Lake according to state law, unless otherwise designated.

36 CFR §2.10 — CAMPING AND FOOD STORAGE

(a) The sites and areas listed below have been designated for camping activities as noted. A permit system has been established for certain campgrounds or camping activities, and conditions for camping and camping activities are in effect as noted:

- Camping is permitted only in numbered and designated sites in established campgrounds. Those campgrounds are:
    - Cold Springs
    - Central
    - Rock Creek
    - Buckhorn
    - Guy Sandy
    - The Point

36 CFR §3.6 — BOATING OPERATIONS

(d)(6) Vessels, including PWCs, shall not be operated at a speed greater than 5 MPH or a NO WAKE speed in the following locations:

- Veteran's Lake and all other lakes 100 acres or smaller
    - This rule is in place to insure the safe navigation of small or shallow bodies of water and to protect these areas as natural habitat for wildlife.

- Anywhere "No Wake" buoys are present.
- On Lake of the Arbuckles within the confines of Guy Sandy Harbor as defined by the breakwaters.
- Within 150 feet of all docks, launch ramps, boats at anchor, boats from which people are fishing, and shoreline areas near campgrounds.

(h) The following areas/sites are designated for the launching of vessels:

- Veterans Lake boat ramp
- Buckhorn boat ramp
- The Point boat ramp
- Guy Sandy boat ramp
- Upper Guy Sandy boat ramp

CFR §3.20 — WATER SKIING

(a) The towing of persons by vessels is permitted in the following areas under the terms and conditions noted:

- On the main body of Lake of the Arbuckles downstream from the "No Wake" buoys in the Buckhorn, Rock Creek, and Guy Sandy arms of the lake.

36 CFR §3.21 — SWIMMING AND BATHING

(a)(1) The following areas are closed to swimming and bathing:

- Boat docks, fishing docks, and boat ramps.
- Travertine Creek, up stream from the Travertine Nature Center.
- Buffalo and Antelope Springs
- Bromide Pavilion Lily Pond
- Vendome Fountain
- 12th Street Fountain
- On the roadway at Sycamore Crossing

APPENDIX B: APPROACH TO EVALUATING SURFACE WATER QUALITY IMPACTS

Objective

Using simplifying assumptions, estimate the minimum (threshold) volume of water in a reservoir or lake below which concentrations of gasoline constituents from personal watercraft or outboards would be potentially toxic to aquatic organisms or humans. Using the estimated threshold volumes, and applying knowledge about the characteristics of the receiving waterbody and the chemical in question, estimate if any areas within the waterbody of interest may present unacceptable risks to human health or the environment.

Overall Approach

Following are the basic steps in evaluating the degree of impact a waterbody (or portion of a waterbody) would experience based on an exceedance of water quality standards / toxicity benchmarks for PWC- and outboard-related contaminants.

1. Determine concentrations of polycyclic aromatic hydrocarbons (PAHs), benzene, and methyl tertiary-butyl ether (MTBE) in gasoline (convert from weight percent to mg/L, as needed) and PAHs in exhaust. The half-life of benzene in water is five hours at 25°C (Verschuren 1983; US EPA 2001).
2. Estimate loading of PAHs, benzene, and MTBE for various appropriate PWC-hour levels of use for one day (mg/day)
3. Find/estimate ecological and human health toxicity benchmarks (risk-based concentrations [RBCs]) (micrograms per liter [μg]/L) for PAHs, benzene, and MTBE.
4. Divide the estimated loading for each constituent (μg) by a toxicity benchmark (μg/L) to determine the waterbody threshold volume (L) below which toxic effects may occur (convert liters to acre-feet).

Estimated hydrocarbon (HC) emissions from personal watercraft and outboards will be significantly reduced in the near future, based on regulations issued by the U.S. Environmental Protection Agency and the California Air Resources Board (CARB) (see the estimated reductions on page 74).

Assumptions and Constants

Several assumptions must be made in order to estimate waterbody threshold volumes for each HC evaluated. Each park should have park-specific information that can be used to modify these assumptions or to qualitatively assess impacts in light of park-specific conditions of mixing, stratification, etc. and the characteristics of the chemicals themselves. The assumptions are as follows:

- BTEX (benzene, toluene, ethyl benzene, and xylene) are volatile and do not stay in the water column for long periods of time. Because benzene is a recognized human carcinogen, it is retained for the example calculations below and should be considered in each environmental assessment or environmental impact statement (Verschuren 1983; US EPA 2001).

- MTBE volatilizes slightly and is soluble in water. MTBE may accumulate in water from day to day, but this is not factored into the calculation and should be considered qualitatively in the assessment.
- PAHs volatilize slightly (depending on structure and molecule size) and may adhere to sediment and settle out of the water column or float to the surface and be photo-oxidized. They may accumulate in water from day to day, but this is not factored into the calculation and should be considered qualitatively in the assessment.
- The toxicity of several PAHs increases (by several orders of magnitude) when the PAHs are exposed to sunlight. This was not incorporated because site-specific water transparency is not known, and should be discussed qualitatively.
- The threshold volume of water will mix vertically and aerially with contiguous waters to some extent, but the amount of this mixing will vary from park to park and location to location in the lake, reservoir, river, etc. Therefore, although the threshold volume calculation assumes no mixing with waters outside the "boundary" of the threshold volume of water, this should be discussed in the assessment after the threshold volume is calculated. The presence or absence of a thermocline should also be addressed.
- Volume of the waterbody, or portion thereof, is estimated by the area multiplied times the average depth.

In addition to these assumptions, several constants required to make the calculations were compiled from literature and agency announcements. Gasoline concentrations are provided for benzene, MTBE and those PAHs for which concentrations were available in the literature. Constants used are:

- Gasoline emission rate for two-stroke personal watercraft: 3 gal/hour at full throttle (CARB 1998)
- Gasoline emission rate for two-stroke outboards: estimated at approximately the same as for personal watercraft for same or higher horsepower outboards (80–150 hp); approximately twice that of personal watercraft for small (e.g. 15 hp) outboards. (Note: Assume total hours of use for the various size boats/motors, and that smaller 15 hp motors that exhaust relatively more unburned fuel would probably be in use for a much smaller amount of time than the recreational speedboats and PWC). This estimate is based on data from Allen et al. 1998 (Figure 5). It is noted that other studies may indicate different relative emission rates (e.g., about the same emissions regardless of horsepower, or larger horsepower engines having higher emission rates than smaller engines [CARB 2001]). The approach selected represents only one reasonable estimate.
- 1 gallon = 3.78 liters
- Specific gravity of gasoline: 739 g/L
- 1 acre-foot = 1.234×10^6 L
- Concentration of benzo(a)pyrene (B[a]P) in gasoline: up to 2.8 mg/kg (or 2.07 mg/L) (Gustafson et al. 1997)
- Concentration of naphthalene in gasoline: 0.5% or 0.5 g/100 g (or 3,695 mg/L) (Gustafson et al. 1997)
- Concentration of 1-methyl naphthalene in gasoline: 0.78% or 0.78 g/100 g (or approx. 5,760 mg/L) (estimated from Gustafson et al. 1997)
- Concentration of benzene in gasoline: 2.5% or 2.5 g/100 g (or 1.85×10^4 mg/L) (Hamilton 1996)

- Concentration of MTBE in gasoline: up to 15% or 15 g/100 g (or approx. 1.10×10^5 mg/L) (Hamilton 1996). (Note: MTBE concentrations in gasoline vary from state to state. Many states do not add MTBE.)
- Estimated emission of B(a)P in exhaust: 1080 µg/hr (from White and Carroll, 1998, using weighted average B(a)P emissions from 2-cylinder, carbureted two-stroke liquid cooled snow mobile engine using gasoline and oil injected Arctic Extreme injection oil, 24-38:1 fuel:oil ratio. Weighted average based on percentage of time engine was in five modes of operation, from full throttle to idle).
- Estimated amount of B(a)P exhaust emissions retained in water phase = approximately 40% (based on value for B(a)P from Hare and Springier, quoted in North American Lake Management Society 2001).

Toxicity Benchmarks

A key part of the estimations is the water quality criterion, standard, or toxicological benchmark for each contaminant evaluated. There are no EPA water quality criteria for the protection of aquatic life for the PWC-related contaminants (US EPA 1999a). There are, however, a limited number of EPA criteria for the protection of human health (via ingestion of water and aquatic organisms or ingestion of aquatic organisms only). Chronic ecotoxicological and human health benchmarks for contaminants were acquired from various sources.

Ecotoxicological benchmarks for benzo(a)pyrene, naphthalene, and benzene are from *Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota: 1996 Revision* (Suter and Tsao 1996). The ecotoxicological benchmarks for benzo(a)pyrene (0.014 µg/L) and benzene (130 µg/L) are Tier II Secondary Chronic Values in Table 1 of Suter and Tsao (1996), which were calculated using methods in the Great Lakes Water Quality Initiative (US EPA 1993). The ecotoxicological benchmark for naphthalene (62 µg/L) is the EPA Region 4 chronic screening value (Table 3 of Suter and Tsao 1996). This screening value was chosen for use as a conservative mid-range value considering the wide range of chronic values for naphthalene (12-620 µg/L) shown in Suter and Tsao (1996). The ecotoxicological benchmarks for 1-methyl naphthalene (19 and 34 µg/L) are based on LC_{50} values of 1900 and 3400 µg/L for the marine invertebrate, Dungeness crab (*Cancer magister*), and the fresh water/estuarine fish, sheepshead minnow (*Cyprinodon variegatus*), respectively (USFWS 1987). The MTBE benchmarks of 18,000 and 51,000 µg/L are for marine and fresh water, respectively, and are based on the preliminary chronic water quality criteria presented in Mancini et al. (2002).

State water quality standards (including the numeric standards and descriptive text) must be reviewed and applied, as appropriate for each park being evaluated. Be sure to use the standards or criteria that fit the designated uses for the waters in the park – e.g., is it designated as a drinking water source or used only for support of aquatic life (fishing)? This will determine whether you use the "water plus organism" benchmarks or the "aquatic organisms only" benchmarks. Also be sure you are using the correct benchmark for either freshwater or marine/estuarine locations if there are different numbers provided for these two environments.

Following are the default toxicity benchmarks for the PAHs, benzene, and MTBE having gasoline concentration information:

Chemical	Ecotoxicological Benchmark (µg/L)	Source	Human Health Benchmark** (µg/L)	Source
Benzo(a)pyrene	0.014	Suter and Tsao 1996	0.0044** 0.049***	US EPA 1999a
Naphthalene	62	Suter and Tsao 1996	--	--
1-methyl naphthalene	19* 34*	USFWS 1987	--	--
Benzene	130	Suter and Tsao 1996	1.2** 71***	US EPA 1999a
MTBE****	18,000 51,000	Mancini et al. 2002	13	CA DHS 2002

* Based on LC_{50}s of 1900 and 3400 µg/L for dungeness crab and sheepshead minnow, respectively (19 µg/L used for marine/estuarine calculations; 34 µg/L used for freshwater calculations).

** Based on the consumption of water and aquatic organisms.

*** Based on the consumption of aquatic organisms only.

**** Ecotoxicological benchmarks, which are considered preliminary chronic water quality criteria, are 18,000 µg/L for marine and 51,000 µg/L for freshwater. There is no EPA human health benchmark, but California DHS (2002) has established a primary maximum contaminant level (MCL) of 13 µg/L.

Example Calculations

Calculations of an example set of waterbody volume thresholds are provided below for the chemicals listed above together with their concentrations in gasoline and available toxicity benchmarks.

Loading to Water

Loadings of the five contaminants listed above are calculated for one day assuming 10 personal watercraft operate for four hours (40 PWC-hours), each discharging 11.34 L gasoline per hour and having concentrations in fuel or exhaust as listed.

Benzo(a)pyrene (from the fuel): 40 PWC-hrs × 11.34 L gas/hr × 2.07 mg/L = 939 mg

Benzo(a)pyrene (from the gas exhaust): 40 PWC-hrs × 1080 µg/hr × 1/1000 mg/µg × 0.40 = 17 mg

Total B(a)P = 956 mg

Naphthalene: 40 PWC-hrs × 11.34 L gas/hr × 3695 mg/L = 1.68×10^6 mg

1-methyl naphthalene: 40 PWC-hrs × 11.34 L gas/hr × 5764 mg/L = 2.62×10^6 mg

Benzene: 40 PWC-hrs × 11.34 L gas/hr × 1.85×10^4 mg/L = 8.39×10^6 mg

MTBE: 40 PWC-hrs × 11.34 L gas/hr × 1.10×10^5 mg/L = 4.99×10^7 mg

Loadings of contaminants from two-stroke outboards should be estimated based on the estimated loading based on the horsepower of the outboards involved (see "Assumptions and Constants" above) and the estimated hours of use, based on the types of boats and the pattern of use observed.

Threshold Volumes

Threshold volumes of water (volume at which a PWC- or outboard-related contaminant would equal the benchmarks listed above) are calculated by dividing the estimated daily loadings (mg of contaminant) for the number of operational hours (e.g., 40 PWC-hours) by the listed toxicity benchmark concentrations (µg/L), correcting for units (1 mg = 10^3 µg), and converting from liters to acre-feet (1 ac-ft = 1.234 x 10^6 L):

Protection of Freshwater Aquatic Organisms

Benzo(a)pyrene: 956 mg B(a)P × 10^3 µg/mg / 0.014 µg/L = 6.8 × 10^7 L or 55 ac-ft

Naphthalene: 1.68 × 10^6 mg naphthalene × 10^3 µg/mg / 62 µg/L = 2.71 × 10^7 L or 22 ac-ft

1-methyl naphthalene: 2.62 × 10^6 mg 1-methyl naphthalene × 10^3 µg/mg / 34 µg/L = 7.69 × 10^7 L or 62 ac-ft

Benzene: 8.39 × 10^6 mg benzene × 10^3 µg/mg / 130 µg/L = 6.45 × 10^7 L or 52 ac-ft

MTBE: 4.99 × 10^7 mg MTBE × 10^3 µg/mg / 51,000 µg/L = 9.78 × 10^5 L or 0.79 ac-ft

Based on these estimates and assumptions, 1-methyl naphthalene appears to be the contaminant (of those analyzed) that would be the first to accumulate to concentrations potentially toxic to freshwater aquatic organisms (i.e., it requires more water [62 ac-ft] to dilute the contaminant loading to a concentration below the toxicity benchmark). However, the threshold volumes are very similar for 1-methyl naphthalene, benzo(a)pyrene, and benzene.

Protection of Human Health

Benzo(a)pyrene: 956 mg B(a)P × 10^3 µg/mg / 0.0044 µg/L = 2.17 × 10^8 L or 176 ac-ft

Benzene: 8.39 × 10^6 mg benzene × 10^3 µg/mg / 1.2 µg/L = 6.99 × 10^9 L or 5,670 ac-ft

MTBE: 4.99 × 10^7 mg MTBE × 10^3 µg/mg / 13 µg/L = 3.83 × 10^9 L or 3,110 ac-ft (If the CA MCL of 13 µg/L for fresh water is used)

The California public health goal for MTBE is a drinking water–based MCL and is not as broadly applicable as the other criteria used in this analysis. However, it may be of interest, since MTBE is very soluble, and MTBE concentration could be an issue if the receiving body of water is used for drinking water purposes and MTBE is not treated. Using the numbers provided above, benzene would be the first PWC-related contaminant in these example calculations that would reach unacceptable levels in surface water; however, volatilization of benzene from water to air was not included in the calculation. MTBE would be the next contaminant to reach unacceptable concentrations. If human health water quality criteria for ingestion of aquatic organisms only were used for benzo(a)pyrene and benzene (0.049 µg/L and 71 µg/L, respectively), the corresponding threshold volumes would be 15.8 acre-feet and 95.8 acre-feet.

As a result of the estimated reductions in HC emissions (from the unburned fuel) in response to EPA regulations (listed above), additional personal watercraft and/or outboards may be used in the parks without additional impacts to water quality. For example, based on the expected overall reductions from EPA (1996a, 1997), up to twice the current number of personal watercraft/outboards may be used in a given area in 2012 without additional impacts to water quality over current levels. Effects on noise levels, physical disturbance, or hydrocarbon emissions that are products of combustion (e.g., B[a]P) may not be similarly ameliorated by the reduced emission regulations.

Application of Approach

Use of the approach described above for evaluating possible exceedance of standards or other benchmarks must be adapted to the unique scenarios presented by each park, PWC use, and waterbody being evaluated. State water quality standards (including the numeric standards and descriptive text) were reviewed and applied, as appropriate.

Factors that would affect the concentration of the contaminants in water must be discussed in light of the park-specific conditions. These factors include varying formulations of gasoline (especially for MTBE); dilution due to mixing (e.g., influence of the thermocline), wind, currents, and flushing; plus loss of the chemical due to volatilization to the atmosphere (Henry's Law constants can help to predict volatilization to air; see Yaws et al. 1993); adsorption to sediments and organic particles in the water column (e.g., PAHs), oxidation, and biodegradation (breakdown by bacteria). Toxicity of phototoxic PAHs may be of concern in more clear waters, but not in very turbid waters.

The chemical composition of gasoline will vary by source of crude oil, refinery, and distillation batch. No two gasolines will have the exact same chemical composition. For example, B(a)P concentrations may range from 0.19 to 2.8 mg/kg, and benzene concentrations may range from 0 to 7% (2 to 3% is typical). MTBE concentrations will vary from state to state and season to season, with concentrations ranging from 0 to 15%. The composition of gasoline exhaust is dependent on the chemical composition of the gasoline and engine operating conditions (i.e., temperature, rpm, and oxygen intake). If site-specific information is available on gasoline and exhaust constituents, they should be considered in the site-specific evaluation. If additional information on the toxicity of gasoline constituents (e.g., MTBE) become available, they should be considered in the site-specific evaluation.

Lastly, results of the studies included in the collection of papers entitled "Personal Watercraft Research Notebook" provided by the NPS staff, can be used to provide some framework for your analysis. The following table summarizes some of the results presented in various documents on the concentrations of benzene, PAHs, and MTBE.

Table B-1: Pollutant Concentrations Reported in Water

Pollutant	Source(s)	Levels Found	
		"Lower Use" (e.g. open water, offshore locations; reduced motorized watercraft use)	"Higher Use" (e.g., nearshore, motorized watercraft activity high)
Benzene	*Lake Tahoe Motorized Watercraft Report* (Allen et al. 1998); several studies reported		
	1. USGS	1. <0.032 µg/l	1. 0.13 – 0.33 µg/l
	2. Miller and Fiore	2. ≤0.3 µg/l	2. just over 1 µg/l
	3. U of CA	3. <0.1 µg/l	3. 0.1 – 0.9 µg/l
PAHs	A. Mastran et al.	A. All below detection limits (<0.1 µg/l for pyrene and naphthalene; <2.5 µg/l for B(a)P, B(a)A, chrysene)	A. Total PAHs – up to 4.12 µg/l in water column; total PAHs – up to 18.86 µg/l in surface sample at marina, with naphthalene at 1 µg/l; B(a)P – ≥2.3 µg/l
	B. Oris et al.	B. Experiment #1 – 2.8 ng/l phototoxic PAHs	B. Experiment #1 – ± 45 ng/l photo-toxic PAHs; 5–70 ng/L total PAHs
MTBE	A. *Lake Tahoe Motorized Watercraft Report* (Allen et al. 1998); several studies reported		
	1. USGS	1. 0.11 – 0.51 µg/l	1. 0.3 – 4.2 µg/l
	2. Miller and Fiore	2. ≤3 µg/l	2. 20 µg/l (up to approx. 31 µg/l)
	3. U of CA	3. less than nearshore area	3. up to 3.77 µg/l
	4. U of Nevada – Fallen Leaf Lake	4. --	4. 0.7 – 1.5 µg/l
	5. Donner Lake (Reuter et al. 1998)	5. <0.1 µg/l	5. up to 12 µg/l (Dramatic increase from 2 to 12 µg/l from July 4 to 7)
	B. NPS, VanMouwerik and Hagemann 1999		
	6. Lake Perris	6. 8 µg/l (winter)	6. up to 25 µg/l
	7. Shasta Lake		7. 9–88 µg/l over Labor Day weekend
	8. 3-day Jet Ski event		8. 50–60 µg/l
	9. Lake Tahoe		9. often within range of 20–25 µg/l, with max of 47 µg/l

APPENDIX C: LETTERS OF CONSULTATION

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Ecological Services
222 S. Houston, Suite A
Tulsa, Oklahoma 74127

In Reply Refer To:
FWS/R2/OKES/
02-14-03-I-0025

October 16, 2002

CHICKASAW
NATIONAL RECREATION ARE
RECEIVED

OCT 18 2002

SUPERINTENDENT
ADMINISTRATION
RANGER DIVISION
MAINT DIVISION
INTERP DIVISION
RES MGT DIV

John F. Shireman, Superintendent
Chickasaw National Recreation Area
National Park Service
1008 West 2nd Street
Sulphur, Oklahoma 73086

Subject: L3415 (CHIC) PWC

Dear Mr. Shireman:

The U. S. Fish and Wildlife Service has reviewed your letter dated September 26, 2002, requesting information concerning endangered and threatened species and their habitats that may exist at the Chickasaw National Recreation Area in Murray County, Oklahoma. The National Park Service is preparing an Environmental Assessment to address alternatives for personal watercraft use on the CNRA. Our comments are submitted in accordance with Section 7 of the Endangered Species Act (87 Stat. 884, as amended 16 U.S.C. 1531 *et seq.*).

Our data indicates the following federally-listed species occur within Murray County:

- Interior least tern, *Sterna antillarum*
- Whooping crane, *Grus americana*
- Bald eagle, *Haliaeetus leucocephalus*

Our data also indicate the following rare species occur within Murray County.

- Alligator snapping turtle, *Macroclemys temminckii*
- Oklahoma cave amphipod, *Allocrangonyx pellluscidus*

The bald eagle likely uses the CNRA during the winter as a roost site or for foraging and similar daytime activities. Potentially, the bald eagle could use the CNRA for nesting. Bald eagles have attempted to nest near Davis, Oklahoma, although there have not been any documented nesting attempts in this area since 1995. The whooping crane could use the CNRA during the spring (April - May) or fall (October - November) migration, although this is unlikely. Your EA should address use of the CNRA by these species under each of your proposed alternatives.

Our data indicate that the Oklahoma cave amphipod and the alligator snapping occur about 10 miles west of the CNRA. While these species are not legally protected under the Endangered Species Act, the Service provides this information for consideration during your environmental review process. The abundances of these species are known to be declining throughout all or a portion of their range. We encourage efforts to avoid or minimize adverse impacts to rare and imperiled species. Conservation of these species now may preclude the need for federal listing in the future. These species could potentially be within or downstream of the CNRA and should also be addressed in your EA.

We appreciate the opportunity to provide comments. If you have any questions or need further assistance with this project, please contact Hayley Dikeman of this office at 918-581-7458, extension 239.

Sincerely,

for Jerry J. Brabander
Field Supervisor

cc: Director, Natural Resources Section, ODWC, Oklahoma City,

HD:beu:02-14-03-I-0025 Chickasaw Nat Rec Area watercraft EA Murray Co.wpd

WILDLIFE CONSERVATION COMMISSION

Lewis Stiles, CHAIRMAN
Mac Maguire, VICE CHAIRMAN
Douglas Schones, SECRETARY
John D. Groendyke, MEMBER
John S. "Jack" Zink, MEMBER
Harland Stonecipher, MEMBER
Bruce Mabrey, MEMBER
Bill Phelps, MEMBER

OKLAHOMA

FRANK KEATING, GOVERNOR
GREG D. DUFFY, DIRECTOR

DEPARTMENT OF WILDLIFE CONSERVATION

1801 N. Lincoln P.O. Box 53465 Oklahoma City, OK 73152 PH. 521-3851

CHICKASAW NATIONAL RECREATION AREA
RECEIVED
NOV 07 2002
SUPERINTENDENT
ADMINISTRATION
RANGER DIVISION
MAINT DIVISION
INTERP DIVISION
RES MGT DIV

November 5, 2002

John F. Shireman
Chickasaw National Recreation Area
1008 West 2nd Street
Sulphur, OK 73086

Dear Mr Shireman,

This responds to your letter of September 26, 2002 requesting information regarding the possible presence of state threatened or endangered species as well as any environmental impact for the following:

Project: Personal Watercraft use at Chickasaw Nation Recreation Area

Location: Murray Co., Oklahoma

Please understand that due to time and personnel constraints this Department has not conducted an actual field survey of the proposed site. Therefore, we are unable to provide site-specific information. We have reviewed the information provided for this project against our current records of state endangered and threatened species. Our records are compatible with the Oklahoma Natural Heritage Inventory and it appears that no state listed species would be affected.

Please be sure to contact the US Fish and Wildlife Service's Tulsa office (918-581-7458) to determine if any federally-listed species will be affected. For additional information concerning sensitive species, we recommend that you contact the Oklahoma Natural Heritage Inventory, 111 East Chesapeake, Norman, Oklahoma 73019.

Thank you for the opportunity to comment. If we can be of further assistance, please contact our Natural Resources Section at 405-521-4616.

Sincerely,

Thomas Heuer
Natural Resources Biologist

AnEqualOpportunityEmployer

Oklahoma Historical Society *Founded May 27, 1893*

State Historic Preservation Office • 2704 Villa Prom • Shepherd Mall • Oklahoma City, OK 73107-2441
Telephone 405/521-6249 • Fax 405/947-2918

CHICKASAW NATIONAL RECREATION AREA
RECEIVED
OCT 31 2002

- ✓ SUPERINTENDENT
- ADMINISTRATION
- RANGER DIVISION
- MAINT DIVISION
- INTERP DIVISION
- RES MGT DIV

October 29, 2002

Mr. John (Rick) Shireman, Supt.
National Park Service
Chickasaw National Recreation Area
1008 West 2nd Street
Sulphur, OK 73086

RE: File #0011-03; Environmental Assessment for Personal Watercraft Use at Chickasaw National Recreation Area

Dear Mr. Shireman:

We have received and reviewed the documentation submitted on the referenced project in Murray County. Additionally, we have examined the information contained in the Oklahoma Landmarks Inventory (OLI) files and other materials on historic resources available in our office. We find that there are no known historic properties affected within the referenced project's area of potential effect.

In addition to our review, you must contact the Oklahoma Archeological Survey (OAS), 111 E. Chesapeake, #102, Norman OK 73019-5111 (#405/325-7211, FAX #405/325-7604), to obtain a determination about the presence of prehistoric resources that may be eligible for the National Register of Historic Places. Should the OAS conclude that there are no prehistoric archeological sites or other types of "historic properties," as defined in 36 CFR Part 800.16(l), which are eligible for inclusion in the National Register of Historic Places within the project area and that such sites are unlikely to occur, we concur with that opinion.

The OAS may conclude that an on-site investigation of all or part of the project impact area is necessary to determine the presence of archeological resources. In the event that such an investigation reveals the presence of prehistoric archeological sites, we will defer to the judgment of the OAS concerning whether or not any of the resources should be considered "historic properties" under the Section 106 review process. If sites dating from the historic period are identified during the survey or are encountered during implementation of the project, additional assessments by the State Historic Preservation Office will be necessary.

Should further correspondence pertaining to this project be necessary, the above underlined file number must be referenced. If you have any questions, please contact Charles Wallis, RPA, Historical Archeologist, at 405/521-6381. Thank you.

Sincerely,

Melvena Heisch

Melvena Heisch
Deputy State Historic
Preservation Officer

MH:bh

Oklahoma Archeological Survey
THE UNIVERSITY OF OKLAHOMA

L3415

CHICKASAW
NATIONAL RECREATION AREA
RECEIVED
OCT 01 2002
SUPERINTENDENT
ADMINISTRATION
RANGER DIVISION
MAINT DIVISION
INTERP DIVISION
RES MGT DIV

September 30, 2002

Rick Shireman
National Park Service
Chickasaw National Recreation Area
1008 West 2nd Street
Sulphur, Oklahoma 73086

RE: Environmental Assessment for Personal Watercraft use at Chickasaw National Recreation Area, Murray County, Oklahoma.

Dear Mr. Shireman:

Our office has no objections to the referenced project. The nature of the project is such that it should have no impact on the prehistoric cultural or archaeological resources of Oklahoma. This review is conducted in cooperation with the State Historic Preservation Office, Oklahoma Historical Society.

Sincerely,

Amy Spears
Staff Archeologist

Robert L. Brooks
State Archeologist

:ls

111 E. Chesapeake, Room 102, Norman, Oklahoma 73019-5111 PHONE: (405) 325-7211 FAX: (405) 325-7604
A UNIT OF ARTS AND SCIENCES SERVING THE PEOPLE OF OKLAHOMA

GLOSSARY

BTEX — benzene, toluene, ethylbenzene, and xylene

National Ambient Air Quality Standards (NAAQS) — Concentrations of criteria pollutants in ambient air (outdoor air to which the public may be exposed) below which it is safe for humans or other receptors to be permanently exposed. The Clean Air Act establishes two types of national air quality standards. **Primary standards** set limits to protect public health, including the health of "sensitive" populations such as asthmatics, children, and the elderly. **Secondary standards** set limits to protect public welfare, including protection against decreased visibility, damage to animals, crops, vegetation, and buildings.

Nonroad Model — An air quality emissions estimation model developed by the U.S. Environmental Protection Agency to estimate emissions from various spark-ignition type "nonroad" engines. The June 2000 draft of the nonroad model was used to estimate air pollutant emissions from personal watercraft. It is available at <http://www.epa.gov/otaq/ nonrdmdl.htm>.

Personal Watercraft (PWC) — As defined in 36 CFR §1.4(a) (2000), refers to a vessel, usually less than 16 feet in length, which uses an inboard, internal combustion engine powering a water jet pump as its primary source of propulsion. The vessel is intended to be operated by a person or persons sitting, standing, or kneeling on the vessel, rather than within the confines of the hull. The length is measured from end to end over the deck excluding sheer, meaning a straight line measurement of the overall length from the foremost part of the vessel to the aftermost part of the vessel, measured parallel to the centerline. Bow sprits, bumpkins, rudders, outboard motor brackets, and similar fittings or attachments, are not included in the measurement. Length is stated in feet and inches.

SUM06 — The cumulation of instances when measured hourly average ozone concentrations equal or exceed 0.06 part per million (ppm) in a stated time period, expressed in ppm-hours.

thermocline — The region in a thermally stratified body of water that separates warmer, oxygen-rich surface water from cold, oxygen-poor deep water. In a thermocline, temperature decreases rapidly with depth.

wake — Moving waves, track, or path that a boat leaves behind when moving across the waters.

SELECTED BIBLIOGRAPHY

Abbreviations used in text bibliographic references:

AWA	American Watercraft Association
CARB	California Air Resources Board
IWL	Izaak Walton League of America
NALMS	North American Lake Management Society
NPS	National Park Service, U.S. Department of the Interior
NTSB	National Transportation Safety Board
OWRB	Oklahoma Water Resources Board
ODEQ	Oregon Department of Environmental Quality
PWIA	Personal Watercraft Industry Association
USACE	U.S. Army Corps of Engineers
USFWS	United States Fish and Wildlife Service, U.S. Department of the Interior
USGS	U.S. Geological Survey, U.S. Department of the Interior

Albers, Peter H.
2000 "Sources, Fate, and Effects of PAHs in Shallow Water Environments." In *Impacts of Motorized Boats on Shallow Water Systems,* Science Workshop Abstracts, November 7–8, 2000, Douglass College Center, Rutgers, the State University of New Jersey. Rutgers, NJ.

Allen, B. C., J. E. Reuther, C. R. Goldman, M. F. Fiore, and G. C. Miller
1998 "Lake Tahoe Motorized Watercraft Report — An Integration of Water Quality, Watercraft Use and Ecotoxicology Issues." Preliminary draft report prepared for the Tahoe Regional Planning Agency.

American Academy of Pediatrics
2000 "Policy Watercraft Use by Children and Adolescents." Policy Statement. *Pediatrics* 105 (no. 2): 452–53.

American Canoe Association
2002 *Hostile Waters — The Impacts of Personal Watercraft Use on Waterway Recreation*, by David Jenkins. Available at <http://www.acanet.org>.

American Watercraft Association
2001 "The Advocate Action Kit: Personal Watercraft and the Environment." Burbank, CA.

Anderson, Franz E.
2000 "Effect of Wave-wash from Personal Watercraft on Salt Marshes." In *Impacts of Motorized Boats on Shallow Water Systems,* Science Workshop Abstracts, November 7–8, 2000, Douglass College Center, Rutgers, the State University of New Jersey. Rutgers, NJ.

Arfsten, D. P., D. J. Schaeffer, and D. C. Mulveny
1996 "The Effects of Near Ultraviolet Radiation on the Toxic Effects of Polycyclic Aromatic Hydrocarbons in Animals and Plants: A Review." *Ecotoxicology and Environmental Safety* 33:1–24.

Asplund, Tim
2001 "The Effects of Motorized Watercraft on Aquatic Ecosystems." Draft paper. Wisconsin Department of Natural Resources and University of Wisconsin, Madison.

Bluewater Network
2001 "Jet Skis Position Paper." Available at <1http://www.earthisland.org/bw/jetskipos.html>.

Branche, C. M., J. M. Conn, J. L. Annest
1997 "Personal Watercraft-Related Injuries: A Growing Public Health Concern." *Journal of the American Medical Association* 278(8): 663–65.

British Columbia Ministry of Water, Land, and Air Protection
1993 "Ambient Water Quality Criteria for Polycyclic Aromatic Hydrocarbon (PAHs)." Available at <http://wlapww.gov.bc.ca/wat/wq/bcguidelines/pahs.html>, accessed Sept. 5, 2002.

Burger, J.
1998 "Effects of Motorboats and Personal Watercraft on Flight Behavior over a Colony of Common Terns." *The Condor* 100: 528–34.

2000 "Managing Personal Watercraft around Tern Colonies." In *Impacts of Motorized Boats on Shallow Water Systems,* Science Workshop Abstracts, November 7–8, 2000, Douglass College Center, Rutgers, the State University of New Jersey. Rutgers, NJ.

Burger, J., and J. Leonard
1999 "Conflict Resolution in Coastal Waters: the Case of Personal Watercraft." *Marine Policy* 24: 61–67.

California Air Resources Board
1997 "Sources and Control of Oxides of Nitrogen Emissions." Stationary Source Control Division and Mobile Source Control Division.

1998 "Proposed Regulations for Gasoline Spark-Ignition Marine Engines, Draft Proposal Summary." Mobile Resources Control Division.

1999 "Fact Sheet – New Regulations for Gasoline Engines." Available at <www.arb.ca.gov/msprog/marine/marine.htm>.

2001 "Outboard Engine and Personal Watercraft Emissions to Air and Water: A Laboratory Study." Prepared by Mobile Source Control Division and Monitoring and Laboratory Division.

California Department of Health Services
2002 "MTBE in California Drinking Water." Prevention Services, Division of Drinking Water and Environmental Management. Available at <www.dhs.ca.gov/ps/ddwem/chemicals/MTBE/mtbeindex.htm> (latest update: Aug. 7, 2002).

Coalition of Parents and Families for Personal Watercraft Safety
2000 "Statistics." Available at <http://www.pwcwatch.org/statistics.htm>.

Continental Shelf Associates for Personal Watercraft Industry Association
1997 "Effects of Personal Watercraft Operation on Shallow-water Seagrass Communities in the Florida Keys." Jupiter, FL.

Dun & Bradstreet
2001 *Industry Norms & Key Business Ratios.* Murray Hill, NJ: Dun & Bradstreet.

Earth Share of California
n.d. "The Hazards of Personal Watercraft." *Making Waves* 15, no. 3. Available at <http://www.earthshareca.org/about/features/skidoos.htm>.

Federal Highway Administration, U.S. Department of Transportation
2000 "Highway Traffic Noise in the United States, Problem and Response" Available at <http://www.fhwa.dot/gov/environment/probresp.htm>.

Florida Fish and Wildlife Conservation Commission
2000 "Buffer Zone Distances to Protect Foraging and Loafing Waterbirds from Disturbance by Personal Watercraft in Florida (Study 7520)." Prepared by J. Rodgers Jr. Bureau of Wildlife Diversity Conservation. Gainesville, FL.

Gustafson, J. B., J. G. Tell, and D. Orem
1997 "Selection of Representative TPH Fractions Based on Fate and Transport Considerations." Final draft. Vol. 3. TPH Criteria Working Group, Fate and Transport Technical Action Group. Amherst Scientific Publishing.

Hamilton, Bruce
1996 "FAQ: Automotive Gasoline." 4 parts. Available at <www.faqs.org/faqs/autos/gasoline-faq>.

Hare, C. T., and K. J. Springier
1973 "Exhaust Emissions from Uncontrolled Vehicles and Related Equipment Using Internal Combustion Engines." Final Report. Part Two: "Outboard Motors." Prepared for the U.S. Environmental Protection Agency by Southwest Research Institute, San Antonio, TX. Available at <http://www.nalms.org/bclss/impactsoutboard.htm>.

Harris Miller Miller & Hanson, Inc.
2002 *Draft Technical Report on Noise: Personal Watercraft and Boating Activities at Glen Canyon National Recreation Area*. Produced under contract to the National Park Service. Harris Miller Miller & Hanson Inc.

Hayes, Reagan
2002 "Can A New Breed of PWC Stem Sales Decline?" *Soundings Trade Only,* February. Soundings Publication LLC. Available at <http://www.pwia.org/articles01.htm>. Site visited June 24, 2002.

Hoagland, Bruce W., Johnson, Forrest L., and Gray, Steven
n.d. "Vegetation Study of Chickasaw National Recreation Area, Oklahoma." On file at Chickasaw National Recreation Area, Sulphur, OK.

Izaak Walton League of America
1999 *Caught in the Wake. The Environmental and Human Health Impacts of Personal Watercraft,* by Laurie C. Martin. Available at <http://www.iwla.org>.

Jacques Cousteau National Estuarine Research Reserve and New Jersey Department of Environmental Protection, Coastal Management Program
2000 "Impacts of Motorized Boats on Shallow Water Systems." Science Workshop Abstracts, Nov. 7–8, 2000. Douglass College Center, Rutgers, the State University of New Jersey.

Jolly, S.
2002 Arbuckle Master Conservancy District. Personal communication with T. Campbell, URS Corporation regarding operation of the Arbuckle Reservoir. September 23.

Kado, Norman Y., Robert F. Okamoto, John Karim, and Paul A. Kuzmicky
2000 "Airborne Particle Emissions from 2-Stroke and 4-Stroke Outboard Marine Engines: Polycyclic Aromatic Hydrocarbon and Bioassay Analyses." *Environmental Science & Technology* 34(13): 2714–20.

Komanoff, Charles, and Howard Shaw
2000 *Drowning in Noise: Noise Costs of Jet Skis in America.* A Report for the Noise Pollution Clearinghouse. Available on the Internet at <http://www.noise.org/library/drowing>.

Landrum, P. F., J. P. Geisy, J. T. Oris, and P. M. Allred
1987 "Photoinduced Toxicity of Polycyclic Aromatic Hydrocarbons to Aquatic Organisms." In *Oil in Freshwater: Chemistry, Biology, Countermeasure Technology,* edited by J.H. Vandermeulen and S. E. Hrudey, 304–18. Ontario, Canada: Pergamon Press.

LAW Engineering and Environmental Sciences, Inc., Arcadis JSA, and RTI
2002 "Economic Analysis of Personal Watercraft Regulations in Chickasaw National Recreation Area." Prepared for the National Park Service. Kennesaw, GA.

Mace, B. E., R. D. Nine, N. N. Clark, T. J. Vanyo, V. T. Remcho, and R. W. Morrison
1998 "Emissions from Marine Engines with Water Contact in the Exhaust Stream." SAE Technical Paper Series. Warrendale, PA.

Mancini, E. R., A. Steen, G. A. Rausina, D. C. L. Wong, W. R. Arnold, F. E. Gostomski, T. Davies, J. R. Hockett, W. A. Stubblefield, K. R. Drottar, T. A. Spring, and P. Errico
2002 "MTBE Ambient Water Quality Criteria Development: A Public/Private Partnership." *Environmental Science and Technology* 36: 125–29.

Mekenyan, O. G., G. T. Ankely, G. D. Veitt, and D. J. Call
1994 "QSARs for Photoinduced Toxicity: I. Acute Lethality of Polycyclic Aromatic Hydrocarbons into Daphnia Magna." *Chemosphere* 28:56782.

Mestre Greve Associates
1992 Noise Assessment for Beaver Basin Rim Road. Pictured Rocks National Lakeshore. Prepared for the National Park Service. Newport Beach, CA.

National Academy of Sciences
1972 *Particulate Polycyclic Organic Matter.* Washington, DC.

National Marine Manufacturers Association
2000 *1999 U.S. Recreational Boat Registration Statistics.* Chicago, IL.

2002 "U.S. Recreational Boat Registration Statistics." Chicago, IL. Available at <http://www.nmma.org/facts/boatingstats/2001/files/populationestimates.asp>.

National Park Service, U. S. Department of the Interior
1979 *General Management Plan, Chickasaw Recreation Area, Oklahoma.*

1985 *General Management Plan Addendum with Development Concept Plan and Environmental Assessment, Veterans Lake, Chickasaw National Recreation Area, Murray County, OK with Finding of No Significant Impact.* Chickasaw National Recreation Area, Sulphur, OK.

1988 *Resource Management Plan for Chickasaw National Recreation Area.* Revised. Chickasaw National Recreation Area, Sulphur, OK.

1994 *Final Amendment to General Management Plan / Development Concept Plan Environmental Assessment and Finding of No Significant Impact.* Chickasaw National Recreation Area, Sulphur, OK.

1995a *How to Apply the National Register Criteria for Evaluation.* Available at <www.cr.nps.gov/nr/publications/bulletins/>.

1995b *Secretary of the Interior's Standards for the Treatment of Historic Properties.* Available at <www2.cr.nps.gov/tps/secstan1.htm>.

1996 The Secretary of the Interior's Standards for the Treatment of Historic Properties and the Guidelines for the Treatment of Cultural Landscapes. Washington, DC.

1997a "Baseline Water Quality Data, Inventory and Analysis." On file at Chickasaw National Recreation Area, Sulphur, OK.

1997b *Draft Environmental Assessment – The Point Campground Improvement, Oklahoma.* On file at Chickasaw National Recreation Area, Sulphur, OK.

1997c *NPS-28: Cultural Resources Management Guideline.* Washington, DC. Available at <http://www.cr.nps.gov/history/online_books/nps28/28contents.htm>.

1998a "Personal Watercraft Use within the NPS System, Proposed Rule." *Federal Register,* 63, no. 178 (Sept. 15): 49312–17. Available at <http://www.nps.gov/refdesk/1pwcrule.html>.

1998b *Water Resources Management Plan, Chickasaw National Recreation Area, OK* Chickasaw National Recreation Area, Sulphur, OK.

1999 "Water Quality Concerns Related to Personal Watercraft Usage," by M. VanMouwerik and M. Hagemann. Technical paper. Water Resources Division, Fort Collins, CO.

2000a *Director's Order #9: Law Enforcement Program,* and *Reference Manual #9: Law Enforcement.* Washington, DC. Available at <http://www.nps.gov/policy/DOrders/DOrder9.html>.

2000b *Director's Order #47: Sound Preservation and Noise Management.* Washington, DC. Available at <http://www.nps.gov/policy/DOrders/DOrder47.html>.

2000c *Management Policies 2001.* Washington, DC. Available at <http://www.nps.gov>.

2001 *Director's Order #12: Conservation Planning, Environmental Impact Analysis, and Decision-making,* and *Handbook.* Washington, DC. Available at <http://www.nps.gov/policy/DOrders/ DOrder12.html> and <http://www.nps.gov/policy/DOrders/RM12.pdf>.

2002a "Chickasaw National Recreation Area Wildlife." Available at <http://www.nps.gov/chic/wildlife.htm>.

2002b "Chickasaw Annual Permit Reports." On file at Chickasaw National Recreation Area, Sulphur, OK.

2002c "PWC Scoping Report, Chickasaw National Recreation Area" (September). Environmental Quality Division, Denver, CO.

2003 "Chickasaw National Recreation Area, Public Use, 1979–2001." Public Use Statistics Office, Denver, CO. Available at <http://www2.nature.nps.gov/stats/>; site visited Jan. 15.

National Research Council, National Academies of Science

2002 *Oil in the Sea III: Inputs, Fates, and Effects.* Washington, DC: National Academy Press.

National Transportation Safety Board

1998 *Personal Watercraft Safety.* Safety Study NTSB/SS-98/01. Washington, D.C.

Noise Unlimited, Inc.

1996 "Boat Noise Tests Using Static and Full-Throttle Measurement Measures." Prepared for the State of New Jersey, Department of Law and Public Safety.

North American Lake Management Society

2002 "Impacts of Outboard Motors on the Aquatic Environment." Based on a report prepared by G. Butcher in 1982. Available at <http://www.nalms.org/bclss/impactsoutboard.htm>; accessed Aug. 8, 2002.

O'Connor, Thomas P.

2000 "Small Boat-derived Chemical Contamination in a National Context." In *Impacts of Motorized Boats on Shallow Water Systems,* Science Workshop Abstracts, November 7–8, 2000, Douglass College Center, Rutgers, the State University of New Jersey. Rutgers, NJ.

Oklahoma Department of Environmental Quality, Air Quality Division

2002 "2002 Oklahoma Ozone, Highest 8 Hour Averages." Available at <http://www.deq.state.ok.us/ AQDnew/monitoring/charts/oz8hr-02.htm>.

Oklahoma Natural Heritage Inventory

2001 Federal and State Endangered or Threatened Species by County. Oklahoma Biological Survey, Norman, OK. Available at <http://www.biosurvey.ou.edu/pub/countrypr.pdf>.

Oklahoma Water Resources Board

2002 *Oklahoma's Water Quality Standards.* Title 785 Chapter 45. Effective July 1.

Ostrander, Gary.

2000 Continued Expression of Malignant Neoplasms in Gizzard Shad at Arbuckle Lake: Ten Years Later. Final Report. Johns Hopkins University, Baltimore, MD. December.

Oregon Department of Environmental Quality

1999 "Carbureted 2-stroke Marine Engines: Impacts on the Environment and Voluntary Policy Options to Encourage Their Replacement." Final report. Prepared by Mindy Correll, Pollution Prevention Team. Portland, OR. Available at <http://www.deq.state.or.us/programs/P2/reports/marine_engines.html.>.

Oris, J. T., A. C. Hatch, J. E. Weinstein, R. H. Findlay, P. J. McGinn, S. A. Diamond, R. Garrett, W. Jackson, G. A. Burton, B. Allen

1998 "Toxicity of Ambient Levels of Motorized Watercraft Emissions to Fish and Zooplankton in Lake Tahoe, California/Nevada, USA." Poster 3E-P005, presented at the 8th Annual Meeting of the European Society of Environmental Toxicology and Chemistry, April 14–18, 1998, University of Bordeaux, Bordeaux, France.

Ostrander, G.K.
2000 *Continued Expression of Malignant Neoplasms in Gizzard Shad at Arbuckle Lake Ten Years Later*. Final Report 7515-8130-NPZ-N-252Z-8-$20,000. Department of Biology, Johns Hopkins University. December 27.

Parker, Ron M.
1981 "The Perception of Conflict in the Recreation Experience of Water Skiers and Boat Fishermen at Lake Arbuckle, Chickasaw National Recreation Area." M.S. thesis, University of Wyoming, Laramie.

Pearce, D., and D. Moran
1994 *The Economic Value of Biodiversity*. London: Earthscan Publication.

Personal Watercraft Industry Association
2000 "Sound Level Comparisons." Available at <http://www.pwia.org/Snd_Graf.htm>.

n.d. "Personal Watercraft and Sound." Available at <http://www.pwia.org/Snd_PWC.htm>. Accessed in 2002.

Robinson, S. J.
2002a "Company Looking for Water." *The Daily Ardmoreite.* June 11.

2002b "Ardmore's Drinking Water Has Traveled Many a Mile." *The Daily Ardmoreite.* August 11.

Rodgers, James A., Jr., and Stephen T. Schwikert
2002 "Buffer-Zone Distances to Protect Foraging and Loafing Waterbirds from Disturbance by Personal Watercraft and Outboard-Powered Boats." *Conservation Biology* 16 (February): 216–24.

Rosenberger, Randall, and John Loomis
2000 "Using Meta-Analysis for Benefit Transfer: In-Sample Convergent Validity Tests of an Outdoor Recreation Database." *Water Resources Research* 36(4): 1097–1107.

Sea-Doo
2000 "Personal Watercraft FACTS." Available at <http://www.ozpwc.com/thefacts.html>.

2001a "Bombardier Announces Revolutionary New O.P.A.S. System." Available at <http://www.seadoo.com/usa/seadoo_today/news/010827.html>.

2001b "The New 155 hp, 1494 cc 4-TEC, Four-Stroke." Available at <http://www.seadoo.com>.

Society of Automotive Engineers
2001 "Exterior Sound Level Measurement Procedure for Pleasure Motorboats." J34. Marine Sound Level Subcommittee. Available on the Internet at <www.sae.org>.

Soil Conservation Service, U.S. Department of Agriculture
1984 "Soil Survey of Murray County, Oklahoma."

Stevenson, J. C., and W. C. Dennison
2000 "The Potential Impacts of Recreational Boating on Submersed Aquatic Vegetation in Upper Chesapeake Bay." In *Impacts of Motorized Boats on Shallow Water Systems,* Science Workshop Abstracts, November 7–8, 2000, Douglass College Center, Rutgers, the State University of New Jersey. Rutgers, NJ.

Suter, G. W., and C. L. Tsao
1996 *Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota*. Rev. ES/ER/TM-96/R2. Oak Ridge National Laboratory, TN.

Tahoe Regional Planning Agency
1998 "Lake Tahoe Motorized Watercraft Report — An Integration of Water Quality, Watercraft Use, and Ecotoxicology Issues." Preliminary draft report prepared for the Tahoe Regional Planning Agency.

1999 *Environmental Assessment for the Prohibition of Certain Two-Stroke Powered Watercraft.*

Tjarnlund, U., G. Ericson, E. Lindersjoo, I. Petterson, and L. Balk
1995 "Investigation of the Biological Effects of 2-Cycle Outboard Engines' Exhaust on Fish." *Marine Environmental Research* 39: 313–16.

Tjarnlund, U., G. Ericson, E. Lindesjoo, I. Petterson, G. Akerman, and L. Balk
1996 "Further Studies of the Effects of Exhaust from Two-Stroke Outboard Motors on Fish." *Marine Environmental Research* 42: 267–71.

U.S. Army Corps of Engineers.
1996 "Pertinent Data – Lake of the Arbuckle's, Oklahoma." Available at <http://www.swt.usace.army.mil/projects/pertdata/l_arbuck.htm>; site accessed Sept. 16. 2002.

U.S. Census Bureau, U.S. Department of Commerce
2000 "Census Data from the 2000 Census."

U.S. Environmental Protection Agency
1974 "Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an adequate Margin of Safety." EPA 550/9-74-004. Washington, DC. Cited in Izaak Walton League of America, 1999, *Caught in the Wake. The Environmental and Human Health Impacts of Personal Watercraft,* by Laurie C. Martin.

1993 *Great Lakes Water Quality Initiative Criteria: Documents for the Protection of Aquatic Life in Ambient Water.* Draft. PB93-154656. National Technical Information Service. Springfield, VA.

1994 "The Effects of Marine Engine Exhaust Emissions on Water Quality: Summary of Findings of Various Research Studies." Office of Air and Radiation.

1996a "Air Pollution Control; Gasoline Spark-Ignition Marine Engines; New Nonroad Compression-Ignition and Spark-Ignition Engines, Exemptions; Rule." *Federal Register* 61 (Oct. 4): 52087–106.

1996b "Emission Standards for New Gasoline Marine Engines." EPA 420-F-96-012. EPA Environmental Fact Sheet. Office of Mobile Sources, Ann Arbor, MI.

1996c *Regulatory Impact Analysis: Control of Air Pollution Emission Standards for New Nonroad Spark-Ignition Marine Engines.* ANR-443. Office of Air and Radiation, Office of Mobile Sources, Engine Programs and Compliance Division, Ann Arbor, MI

1997 "Control of Air Pollution; Amendment to Emission Requirements Applicable to New Gasoline Spark-Ignition Engines." *Federal Register* 62 (April 2): 15805–08.

1998 "National Recommended Water Quality Criteria." *Federal Register* 63 (Dec. 10): 68353–64.

1999a "National Recommended Water Quality Criteria — Correction." EPA822-Z-99-001. Office of Water.

1999b "Power Boating and America's Waters." Available at <http://www.epa.gov/CEIS/atlas/ohiowaters/uses/power_boating_and_america.htm>.

2000a "Recreational Vehicles, Marine Engines." Region III, Air Protection Division. Available at <http://www.epa.gov/reg3artd/vehicletran/vehicles/recreational_vehicles.htm>.

2000b *Air Trends for the Year 2000.* Available at <http://www.epa.gov/airtrends/vis2.html>.

2001 "National Primary Drinking Water Regulations: Technical Fact Sheet on Benzene." Office of Water. Available at <www.epa.gov/ogwdw000/dwh/t-voc/benzene.htm>.

United States Fish and Wildlife Service, U.S. Department of the Interior
1987 "Polycyclic Aromatic Hydrocarbon Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review," by R. Eisler. Biological Report 85; Contaminant Hazard Reviews Report 11. Laurel, MD.

2002 Personal communication with Ken Frazier, Ecological Services, Tulsa, OK and <http://ecos.fws.gov/servlet/TESSWebpageUsaLists?state=OK>.

U.S. Department of the Interior
n.d. *Final Environmental Impact Statement, Miccosukee 3-1 Exploratory Well, Broward County, Florida.* Washington, DC.

U.S. Geological Survey, U.S. Department of the Interior
2000 "Occurrence and Potential Adverse Effects of Semivolatile Organic Compounds in Streambed Sediment, United States, 1992–1995," by T. J. Lopes and E. T. Furlong. Carson City, NV.

Verschuren, K.
1983 *Handbook of Environmental Data on Organic Chemicals.* 2nd ed. New York: Van Nostrand Reinhold Company.

Vlasich, Brian
1998 "Personal Watercraft: Environmental Effects of a 'Thrill-Craft.'" Claremont Environmental Policy Briefs, Student Edition. Roberts Environmental Center, Claremont McKenna College, Claremont, CA.

Wark, Kenneth, and Cecil F. Warner
1981 *Air Pollution: Its Origin and Control*. 2nd ed. New York: Harper and Row, Publishers.

White, J. J., J. N. Carroll
1998 "Emissions from Snowmobile Engines Using Bio-Based Fuels and Lubricants." Final Report. Prepared for Montana Department of Environmental Quality, Helena, MT.

Winger, Parley V.
2000 "Toxicological Assessment of Aquatic Ecosystems." In *Impacts of Motorized Boats on Shallow Water Systems,* Science Workshop Abstracts, November 7–8, 2000, Douglass College Center, Rutgers, the State University of New Jersey. Rutgers, NJ.

Wong, D. C. L., W. R. Arnold, G. A. Rausina, E. R. Mancini, and A. E. Steen
2001 "Development of a Freshwater Aquatic Toxicity Database for Ambient Water Quality Criteria for Methyl Tertiary-Butyl Ether." *Environmental Toxicology and Chemistry* 20 (5): 1125–32.

Wray, Jacilee, and Alexa Roberts
2001 "Chickasaw National Recreation Area, Ethnohistory of the Associated Park Use and Values." Draft (July 19). National Park Service, Applied Ethnology Program. On file at Chickasaw National Recreation Area, Sulphur, OK.

Yamaha Motor
2001 "World's First 4-Stroke Personal Watercraft." Available at <http://www.yamaha-motor.com/ new/07-19_01_wc_press.html>.

Yaws, C. L., Pan Xiang, and Lin Xiaoyin
1993 "Water Solubility Data for 151 Hydrocarbons. *Chemical Engineering,* 100 (no. 2): 108–11.

Personal Communications

Burrough, S. Chickasaw National Recreation Area. Personal communication with Rachel Wieland, URS, Oct. 2, 2002.

Burrough, S. Chickasaw National Recreation Area. Personal communication with Tom Campbell, URS, Sept. 24, 2002.

Cummins, E. Chickasaw National Recreation Area. Personal communication with M. Foust, NPS, two memos dated July 07 and 16, 2001.

Foust, M. Chickasaw National Recreation Area. Personal communication with Patty Steinholtz, URS, Oct. 10, 2002.

Howery, M. Oklahoma Department of Wildlife Conservation. Personal communication with Paula Daukas, URS, Oct. 16, 2002

Jolly, S. Arbuckle Master Conservancy District. Personal communication with Tom Campbell, URS, Sept. 23, 2002.

Koenig, P. National Park Service. Personal communication with Tom Campbell, URS, Sept. 30, 2002.

Oklahoma Division of Public Safety. Personal communication with Rachel Wieland, URS, Sept. 19, 2002.

Schmidt, M. U.S. Coast Guard. E-mail correspondence with Louis Berger Group, Inc., re: Gateway National Recreation Area, Sept. 4, 2001.

Shireman, R. Chickasaw National Recreation Area. Personal communication with David Jones, URS, Aug. 13, 2002.

Staples, S. Chickasaw National Recreation Area. Personal communication with David Jones, URS Aug. 26, 2002.

Staples, S. Chickasaw National Recreation Area. Personal communication with Rachel Wieland, URS, Sept. 4, 2002, Sept. 7, 2002, and Oct. 7, 2002.

LIST OF PREPARERS

National Park Service

Chickasaw National Recreation Area

John F. (Rick) Shireman, Park Superintendent. Correlated statistical data, verified sources, and attended public meetings; contributed to the development of issues and proposed alternatives, reviewed and edited draft document; and contributed to the writing of the proposed PWC special regulation for Chickasaw National Recreation Area. Experience: 23 years in NPS park operations.

Mark Foust, Chief Ranger. Gathered information, verified sources, attended public meetings, and assisted with alternatives development during the scoping phase; reviewed draft documents for accuracy. Experience: 15 years in NPS law enforcement.

Steve Burrough, Chief of Resource Management. Gathered information, verified sources, attended public meetings, and assisted with alternatives development during the scoping phase; reviewed draft documents for accuracy. Experience: 4 years in NPS resource management.

Susie Staples, Superintendent's Secretary/Public Information Officer. Attended public meetings and correlated public comments; gathered information; prepared and reviewed draft documents. Experience: 10 years National Park Service (6 years in administration, 4 years as superintendent's secretary/public information officer).

Ed Cummins, Supervisory Park Ranger, law enforcement. Gathered information, verified sources, attended a public meeting, and assisted with alternatives development during the scoping phase. Experience: 22 years in the National Park Service in law enforcement.

Eric Reubin, Fee Collection Manager/Park Ranger (law enforcement). Coordinated data collection on PWC use at Chickasaw and assisted with alternatives development during the scoping phase. Experience: 28 years in NPS law enforcement and fee management.

Ron Parker, Chief of Interpretation. Attended public meetings, early planning meetings, and assisted with alternatives development during the scoping phase; reviewed draft documents for accuracy. Experience: 15 years in NPS fee collection, administration, law enforcement, concessions, resource management, and interpretation.

Air Resources Division, Washington Office

Tamara Blett, Ecologist. M. S., Forest Ecology. Assisted in developing air quality methodology. Experience: 15 years NPS and USFS air resource management experience.

John D. Ray, Program Manager for the Gaseous Pollutant Monitoring Program. Ph.D., Chemistry. Assisted in developing air quality methodology. Atmospheric chemist. Experience: 9 years with National Park Service.

Aaron Worstell, Environmental Engineer. B.S., Chemical Engineering. Assisted in developing air quality methodology. Experience: 9 years experience in air quality (5 federal, 4 state).

Environmental Quality Division, Washington Office

Sarah Bransom, Compliance Program Coordinator. MRP (Master's Degree, Environmental Planning). Managed all PWC environmental assessments for the National Park Service. Experience: 24 years NEPA compliance (federal service).

Intermountain Region Support Office

Rick Ernenwein, Overflights and Noise Program Coordinator. B. S., Renewable Natural Resources. Assisted in developing soundscape methodology. Experience: 15 years with NPS noise and NEPA issues; 23 years federal service.

Water Resource Division, Washington Office

Gary Rosenlieb, Hydrologist, Water Quality Program Coordinator. M. S., Water Resources Management. Assisted in developing water quality methodology. Experience: 23 years federal service, with primary experience in water quality management and environmental impact analysis for water resources issues.

Mark VanMouwerik, Contaminants Specialist / CSU Research Associate. M. S., Environmental Health. Worked with fate and effects on contaminants in the environment. Experience: 5 years with National Park Service.

Consultants

URS Corporation

Thomas G. Campbell, Consultant and Leader, Risk Assessment Team. M. S., Marine Biology. Refined approach to evaluating surface water quality impacts. Experience: Over 25 years experience in aquatic and marine ecology, water quality, toxicology, and ecological risk assessment.

David Jones, Senior Environmental Planner, B.A., Landscape Horticulture. Responsible for project management. Experience: Over 12 years experience in NEPA document preparation and management.

Jessica T. Lau, Senior Environmental Scientist. B. A., Botany; B. S. Geology; M. A., Natural Science. Responsible for air quality analysis and technical review. Experience: Over 14 years in air quality, including various NEPA projects.

Robert Mutaw, Cultural Resources Specialist, Ph.D., Anthropology. Responsible for cultural resources analysis and technical review. Experience: Over 23 years in cultural resources analysis, including various NEPA projects.

Lisa Pine, Environmental Planner, B.A. History, M.A. Geography. Responsible for research and report writing. Experience: Over 3 years experience in Environmental Analysis.

Greg Sorensen, Technical Writer/Editor. B. A., International Affairs. Responsible for final editing of document. Experience: 27 years preparing NEPA documents.

Patti Steinholtz, Editor/Graphic Illustrator. B. A., Communications and English. Responsible for editing text and preparing maps. Experience: 9 years.

Nancy VanDyke, Senior Consultant and Leader, Regulatory Team. B. A., Biology and Geography; M. S., Environmental Sciences. Responsible for technical review of document, water quality methodology. Experience: Over 22 years in environmental planning, assessment, and compliance.

Rachel Wieland, Environmental Planner, B.A., Environmental Science and Biology. Responsible for research and EA report writing. Experience: Over 8 years experience in environmental planning, assessment, and NEPA projects.

As the nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering wise use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historic places, and providing for the enjoyment of life through outdoor recreation. The department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people. The department also promotes the goals of the Take Pride in America campaign by encouraging stewardship and citizen responsibility for the public lands and promoting citizen participation in their care. The department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

NPS D-104 (February 2003)